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WHAT IS CYTTARIA DISCIFORMIS?

Irma J. Gamundí (*) & Cecilia A. M. Brion (**)

Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina and Centro Regional Universitario Bariloche, Universidad Nacional del Comahue, Quintral 1250, 8400 S. C. de Bariloche, Río Negro, Argentina.
E-mail: igamundí@crub.uncoma.edu.ar
** Centro Regional Universitario Bariloche, Universidad Nacional del Comahue, Argentina. E-mail: cbrion@crub.uncoma.edu.ar

Keywords: Ascomycota, Basidiomycota, Dacrymycetaceae

Abstract

After examination of the type specimen of *Cyttaria disciformis* Lév. it was concluded that the species is not an Ascomycota but a Basidiomycota belonging to the order Dacrymycetales, family Dacrymycetaceae.

Introduction

Léveillé (1846:254) described *Cyttaria disciformis* under species number 283 as: "Receptaculo orbiculari discoideo emortuarum, tremelloideo flavo stipite brevissimo suffulto, foveolis minutissimis sparsis. Hab.: Chili ad cortices arborum. Cl. Gay, (herb. Mus. Paris)". Under observations it is said that :"le réceptacle de cette petite èspece est orbiculaire, convexe, large de 3 à 6 millimètres, supporté par un court pédicule, qui lui donne quelque ressemblance avec un bouton; la face supérieure présente de très petites fossettes eloignées les unes des autres dans lequelles je nái vu que des longs filaments libres, continus et rameux, avec une couche de cellules allongées, courtes, très pressées et terminées par un renflement presque globuleux renferment un corps opaque et irrégulier. Sous l'influence de la teinture d'iode, les filaments ainsi que les cellules se colorent en jaune brun, tandis que le reste du tissu, composeé des petites cellules polygones, conserve sa couleur blanche".

Fischer (1888:815-842) who revised the type, stated that the fungus in question does not shows identifiable apothecia or primordia of apothecia and that it could be any fungus but *Cyttaria*. Perhaps for that reason, several mycologists who treated taxonomically the genus (Espinosa, 1926, Marchionatto, 1940, Santesson, 1945, Rawlings, 1956, Kobayasi, 1964, 1966, Butin, 1969) excluded *C. disciformis* Lév. from their papers. This fact drew our attention to the name and lead us to investigate the type specimen.

Materials and Methods

For microscopical observations pieces of fruitbodies were soaked in distilled water and 5% KOH. They were sectioned and squashed. As mounting media Melzer's and lactic blue were used.

Results

During the stay at the Paris Museum in October 1964, one of the autors (I. J. G.) examined the putative type specimen of *Cyttaria disciformis* Lév. The label read: "Herbarium Mycologicum Berkeleyanum No. 7937, Chili, C. Gay leg., ad truncus". The exssicata contained one fructification of 6 mm diam., characterised by a cartilaginous consistency, cinnamon reddish colour, with an acute, undulate margin. When rehydrated it was gelatinous. When microscopically examined, its upper surface showed a palisade of clavate cells arising from clamps and below a hyphose structure formed by thin, profusely branched hyphae. No spores were seen. The clavate structures were interpreted as basidioles. The conclusion was that the fungus examined, although immature, was a basidiomycete. These observations confirmed Fisher's view and, for that reason, *C. disciformis* Lév. was not included in papers by Gamundí (1971, 1987) and Crisci, Gamundí & Cabello (1988) on *Cyttariales.*

Recently, we examined the type specimen kept in PC. The label read: "*Cyttaria disciformnis* Lév., Chili, Gay" (Fig. 1). It was impossible to locate the collecting site, but the wood and bark of the host material seems to be of a dicotyledon.

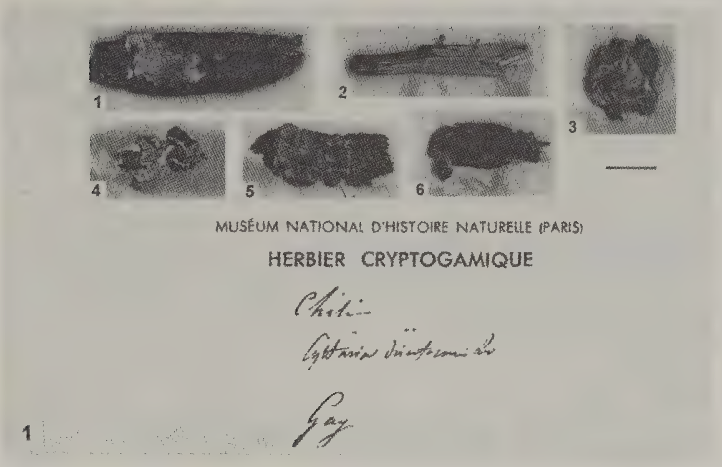
Description

Macroscopic features

The type specimen consists of six pieces of host tissue, which we numbered from 1 to 6 (Fig.1, numbers 1-6). Number 1 shows three discoid fructifications (Fig. 7,1); number 2, two cylindrical fruitbodies (Fig.7.2); number 3, one discoid, substipitate fructification (Fig.7.3); number 4, no fructification (Fig. 7.4); number 5, one discoid–turbinate fruitbody (Fig. 7.5); number 6, one flabelliform, stipitate fruitbody (Fig. 7.6). Macroscopic features common to all of them is the firm, highly cartilaginous, translucent, caramel coloured carpophore when dried, and gelatinous, yellowish fruitbody when soaked in water, arising from the wood. The discoid-turbinate fructifications (numbers 1,3,5, figs. 9-10) are 2-5 mm diameter; the cylindrical ones (number 2, fig. 8) 3-4 mm long x 0.8-1.2 mm diam.; flabelliform (number 6, fig. 11) 7.5 mm long x 4 mm diam.(upper portion), all measures taken on dried material.

Microscopic features

In section the upper surface of the discoid-turbinate basidiomata (numbers 3-5) comprises the palisade layer of the hymenium (Figs. 2-4); the lower and lateral surfaces comprise an ill-differentiated layer of more o less parallel hyphae perpendicular to the surface; the inner portion is a mass of intricate, branched hyphae (Fig. 5), all the structures are embedded in a highly gelatinous matrix. In the flabelliform fructification (number 6) the hymeniun was unilateral and supported by a stipe. The cylindrical fruitbodies (number 2) have the upper end enlarged and convex. As no hymenium was detected, we presume they are immature.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Figs. 1-6. *Cyttaria disciformis* Lév. **Fig. 1.** Type specimen, pieces numbered 1-6.

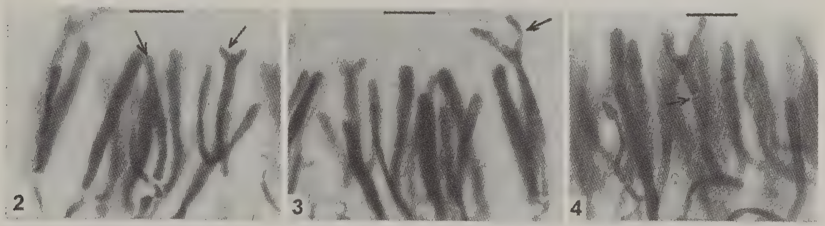

Fig. 2. Hymenium showing basidioles and probasidium (arrows). **Fig. 3.** Hymenium showing bifurcate basidium (arrow). **Fig. 4.** Hymenium showing septate basidium (arrow).

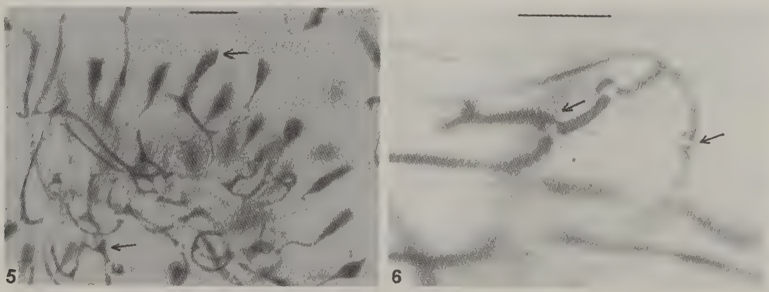

Fig. 5. Cortex (upper arrow) and context (lower arrow). **Fig. 6.** Context showing clamp connections (arrows). Scale bars: Fig. 1 = 1 cm; Figs. 2-5 = 10 µm; Fig. 6 = 20 µm.

Hymenium superior or lateral, with clavate basidioles 27-34 x 2-3 µm diam. at the widest part, cytoplasm intensely stained with lactic blue, dextrinoid (Fig. 2); probasidia cylindrical then bifurcate (Fig. 3), produced in clusters; rare metabasidia apically bifurcate forming two long sterigmata and a transverse septum, arising from a clamp, 27-45 x 3.4 -4.8 µm (Fig. 4); protoplasm granulose to guttulate, cytoplasm staining deep with lactic blue; dikaryophyses cylindrical, rare.

Cortex an ill-defined palisade of hyphae embedded in a gelatinous matrix, ending irregularly, cytoplasm granulose, deeply stained with lactic blue, dextrinoid (sample numbers 1, 3). In sample number 6 the ends are wider (up to 2.4 µm), fusiform, clavate to trapezoidal, with incrusted walls and light brown cytoplasm. (Fig. 5).

Context a mass of hyphae profusely branched (2-3-4 divaricate) embedded in a gelatinous matrix, with clamp connections either simple or forming a loop, (Fig. 6) hyaline, thick walled (walls as thick as lumen), intermixed with brownish, wider hyphae with incrusted walls. (Fig. 5).

Discussion

Léveillé's description is in agreement with our observation regarding the fruitbody, except that we have not seen small cavities in any of the specimens examined, a feature that perhaps led Léveillé to classify the collection as a *Cyttaria*. The filaments and elongated cells which lined "the cavities" described by Léveillé are probably a young hymenium , but no reference was made to asci. Léveillé made no reference to host substrate. This would have provided another clue to the identity of the genus, as *Cyttaria* is parasitic only on *Nothofagus.*

There is enough evidence from our observations of microscopic features (clamp connections, bifurcate metabasidia) that *Cyttaria disciformis* Lév. is a Basidiomycota, Dacrymycetales, Dacrymycetaceae (Hawksworth et al., 1995) and not an Ascomycota, Cyttariales, Cyttariaceae.

The bifurcate basidia are characteristic of Dacrymycetaceae (Kennedy, 1958, Martin, 1952) formerly placed in the Tremellales, but later (McNabb & Talbot, 1973, Reid, 1974, Hawksworth et al., 1995) in the Dacrymycetales.

Unfortunately, we could not see spores, but the structures of the basidioma suggest one of two genera, owing to the upper or lateral position of the hymenium and differentiation of a cortex and a context: *Dacrymyces* Fr. (McNabb, 1973) or *Femsjonia* Fr. (McNabb, 1965).

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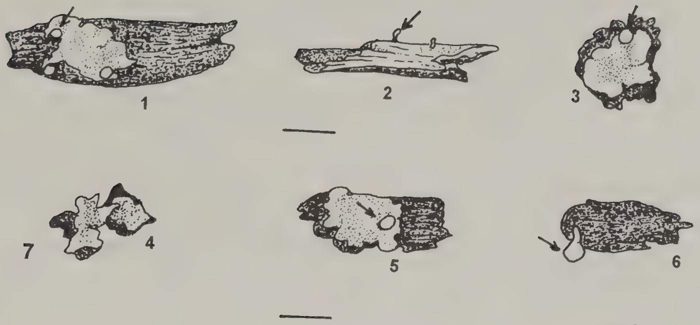

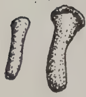
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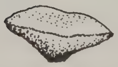
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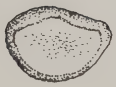
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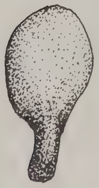
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Fig. 9. Fruitbody of number 3. **Fig. 10**. Fruitbody of number 5. Fig. **11**. Fruitbody of number 6. Scale bars: Fig. 7 = 1cm; Figs. 8-11 = 2 mm.

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See Errata

MYCOTAXON

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A NEW SPECIES OF APHANOASCUS (ASCOMYCOTA) WITH A MALBRANCHEA ANAMORPH FROM MARINE BOTTOM DEPOSITS

Michael V. Pivkin, Yulia V. Khudyakova
Pacific Institute of Bioorganic Chemistry, Far East Branch of the Russian Academy of Sciences, 690022, Vladivostok-22, Russia; e-mail: piboc@eastnet.febras.ru

ABSTRACT

Aphanoascus aciculatus sp. nov. from marine bottom deposits of the Sea of Japan is described.

Key words: Marine fungi, taxonomy.

As part of a programme investigating fungi from marine environments, a collection of hyphomycetes from marine bottom deposits was analysed. The growing of these fungi under various conditions has allowed us to reveal several strains, which form holomorphs of the genus *Aphanoascus* Zukal (Plectomycetes (Benny & Kimbrough, 1980).

Up to now, only few species of Plectomycetes have been found solely in the sea: two species of the genus *Gymnascella* – *G. littoralis* (Orr) Gurrah from marine animals and algae near the west coast of North America (Gurrah, 1985; Kohlmeyer & Volkmann-Kohlmeyer, 1991) and *G. marismortui* Buchalo from water of the Dead Sea (Buchalo *et al.* 1998) as well as *Microasous senegalensis* Arx from mangrove mud in Senegal and Mexico (Arx, 1975; Kohlmeyer, 1986). Members of *Aphanoascus* are keratophiles widely distributed in soils, dung and birds' nests, but have not been found in the sea (Cano & Guarro, 1990; Cano, Guarro & Zaror, 1990; Udagawa & Lichiyama, 1999). Therefore the species described below is of particular interest.

Aphanoascus aciculatus Pivkin et Khudyakova *sp. nov.* (Figs. 1–2)

Etym.: aciculatus = needle shaped, conidia are needle-like under the light microscope.

Coloniae in agaro ad 25° C densae, lente crescunt, cumulae, circa 5–6 mm elevatae, concentrice plicatae, velutinae vel pulveraceae, albae, in centro luteolae vel citreae; reversum incoloratum vel flavum. Mycelio vegetative ex hyphis hyalinis, ramosis, tenuis, levis, septatis, 1.5–4 μm diam. composito.

Ascomata in medium "oryza cum aquata marina" superficialia, sphaerica, non-ostiolata, levia, 400–900 μm diam., brunnea; peridio 4–6 μm crasso, et 3–4 stratis cellularum complanatarum composito, 3–6 x 5–8 μm constant. Asci numerosi, octospori, subglobosi, evanescentes, 6.5–7.5 x 4.5–7 μm. Ascosporae subglobosae vel oblatae, pallide brunneae, unicellulares, 2.2–4 μm diam., 1.5–2.2 μm crassae.

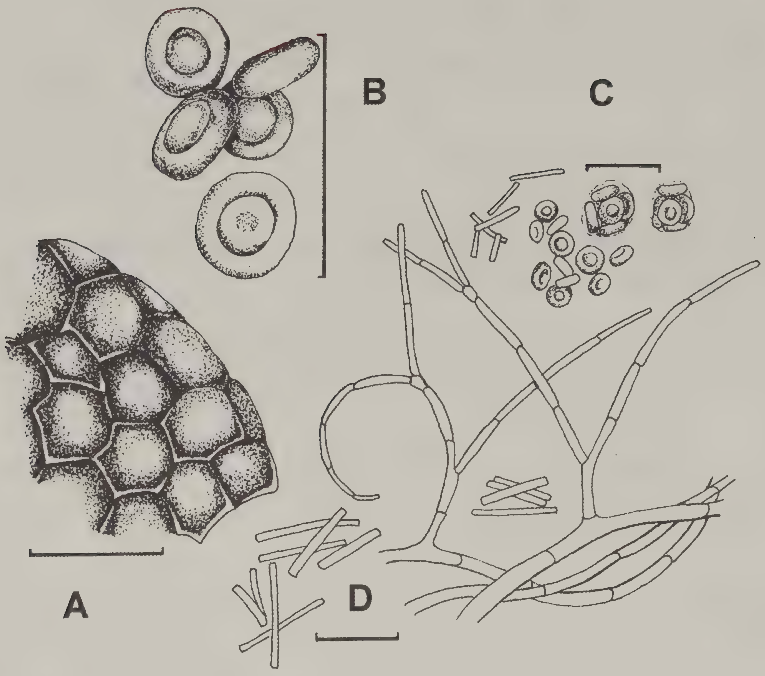

Fig. 1 *Aphanoascus aciculatus* (LE† 211060). A, peridium; B, ascospores; C, asci; D, conidia (bars = 10 μm).

Anamorphosis: *Malbranchea* sp. Hyphae fertiles irregulariter dichotomae; hyphae primariae 1.5–3 μm diam., ramis fertilibus arthroconidis. Arthroconidia hyalina, levia, cylindracea vel leniter curvula, 4–9 (–20) x 1.5–2.2 μm.

Holotypus: LE 211060, ex sedimentis marinus, Russia, regio Primorskiensis, mare Japonicae, sinus Amurensus, 07.08.1998.

Colonies on YpSs and PYE with natural seawater at 25° C are dense, slow-growing (18–22 mm in diameter after 6 weeks), concentrically rugate, velvety at first, becoming powdery, raising in the centre up to 5–6 mm, white, but become yellowish or lemony in the centre, reverse colourless or pale yellow. A lemon yellow pigment diffuses into the agar. The vegetative hyphae are narrow, 1.5–4 μm diameter.

Teleomorph forms on rice medium with seawater after the growing in the flasks during two months. Ascomata are superficial, globose, non-ostiolate, brown, 400–900 μm diameter, glabrous; cleistoperidium of "textura angularis" 4–6 μm thick, 3–4 layers

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†LE – Herbarium of V. L. Komarov Botanical Institute RAS, St. Petersburg.

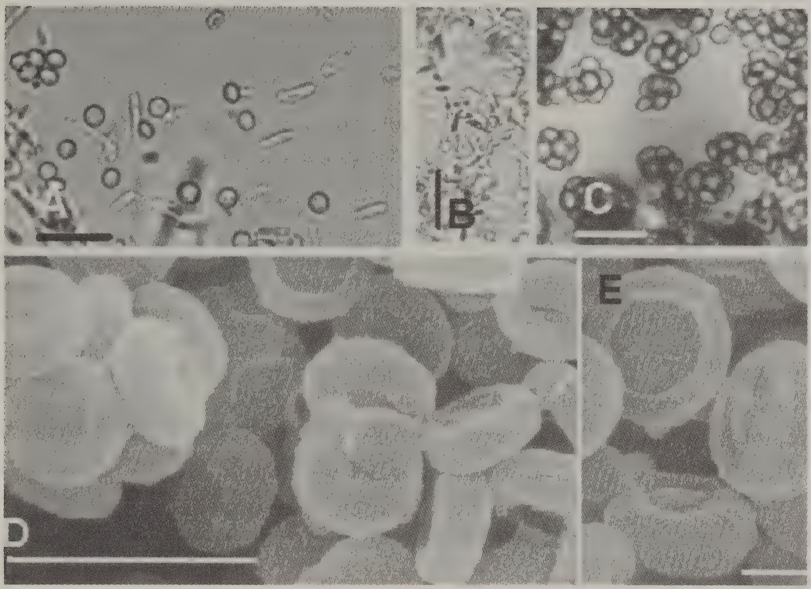

Fig. 2 *Aphanoascus aciculatus* (LE 211060). A, ascospores; B, conidia; C, asci; D, E ascospores (bars A-C = 10 μm, D = 5 μm, E = 1 μm); A-C (LM*); D, E (SEM).

deep; cells are flattened, 3–6 x 5–8 μm. Asci are numerous, globose to subglobose, 6.5–7.5 x 4.5–7 μm, 8-spored, evanescent. Ascospores are unicellular, oblate with polar depressions, smooth under LM to slightly rugose under SEM, light brown, 2.2–4 x 1.5–2.2 μm.

Anamorph: *Malbranchea* sp. Fertile hyphae arise as long side branches from aerial hyphae or as terminal branches of aerial hyphae, often form an irregular dichotomic branching structure. Arthroconidia are hyaline, smooth-walled, cylindrical or slightly bent, 4–9 (–20) x 1.5–2.2 μm.

Holotype: LE 211060, from sea bottom deposits, Russia, the Sea of Japan, Amursky Bay, 07.08.1998.

Material examined: KMM▼ 4688 from sea bottom deposits, the Sea of Japan, Trinity

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*LM – light microscopy, SEM – scanning electron microscopy.

▼KMM – Collection of Marine Microorganisms, Pacific Institute of Bioorganic Chemistry, the Far East Branch of the Russian Academy of Sciences, Vladivostok. In "World Directory of Collections of Culture of Microorganisms. Bacteria, Fungi, and Yeasts" 4th ed. WFCC World Data Center on Microorganisms, 1993.

Bay, 42°34'00" N, 130°57'29" E, at the depths of 17 m, 27.10.1996; KMM 4692 from sea bottom deposits, the Sea of Japan, Amursky Bay, 44°06'52" N, 131°45'40" E, at the depths of 15 m, 07.08.1998; KMM 4698 from sea bottom deposits, the Sea of Japan, Amursky Bay, 44° 06'50" N, 131° 45'38" E, at the depths of 12 m, 07.08.1998.

A. aciculatus belongs to the group of *Aphanoascus* characterized by ascospores with a prominent equatorial rim. Almost all members of this group, including *A. durus* (Zucal) Cano et Guerro, *A. clathratus* Cano et Guerro, *A. hispanicus* Cano et Guerro, *A. terreus* (Randhawa et Sundhu) Apinis (Cano & Guerro, 1990), and *A. punsolae* Cano et Guarro (Cano, Guerro & Zaror, 1990) have *Crysosporium* anamorphs. *A. boninensis* Udagawa et Lichiyama (Udagawa & Lichiyama 1999) have a *Chrysosporium*-like anamorph. In this group *A. aciculatus* and *A. multiporus* Cano et Guarro (Cano & Guerro, 1990) alone have *Malbranchea* anamorph. However *A. multiporus* has pitted large ascospores (5–6 x 3.5–4 µm), whereas ascospores of *A. aciculatus* are smaller and smooth. Under the light microscope ascospores of *A. aciculatus* are allied to *A. durus*, but they are smaller and smooth. Ascospores of *A. durus* are foveate-reticulate, smooth in the poles, 4–4.5 x 2.7–3 µm. Among *Aphanoascus* species, only *A. punsolae* has smooth ascospores that are also larger (4–4.5 x 2–2.5 µm) than those of *A. aciculatus*.

ACKNOWLEDGEMENTS

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MYCOTAXON

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CLAVICEPS PURPUREA VAR. SPARTINAE VAR NOV.: AN ERGOT ADAPTED TO THE AQUATIC ENVIRONMENT

RUSSELL A. DUNCAN, JR.[1], RAYMOND SULLIVAN[1], STEPHEN C. ALDERMAN[2], JOSEPH W. SPATAFORA[3], JAMES F. WHITE, JR.[1]

[1]Department of Plant Biology and Pathology, 59 Dudley Rd., Cook College-Rutgers University, New Brunswick, New Jersey 08901;
[2]USDA/ARS National Forage Seed Production Center, Corvallis, Oregon 97331;
[3]Department of Botany & Plant Pathology, Oregon State University, Corvallis, Oregon 97331

ABSTRACT

We investigated systematic relationships and morphological and ecological features of an ergot that commonly infects species of the maritime grass *Spartina.* Phylogenetic analysis of ribosomal DNA Internal Transcribed Spacer 1 sequences demonstrated that the *Spartina* ergot is placed in a clade with *Claviceps purpurea*. Structural differences of sclerotia distinguish it from the *Claviceps purpurea* var. *purpurea* as seen on rye and other grasses. Sclerotia from *Spartina* are larger and contain large intercellular spaces and have thicker rinds than sclerotia of *C. p. purpurea.* Sclerotia of the *Spartina Claviceps* float in 1% saline and fresh water while those of *C. p. purpurea* sink. In addition, the *Spartina Claviceps* has a unique alkaloid profile. In recognition of the differences between *C. purpurea* and the *Spartina* ergot a new variety, *C. p. spartinae var. nov.*, is proposed.

KEY WORDS: Ascomycetes, Clavicipitaceae, *Spartina*, sclerotia, salt marsh

INTRODUCTION

The genus *Claviceps* was established by Tulasne (1853) for *Sphaeria purpurea* Fries from rye (*Secale cereale* L.) (Saccardo, 1883). To date, over fifty species and varieties of *Claviceps* have been described, based on details of the ascoma, asci, ascospores, sclerotia, conidia, and host range. Species of *Claviceps* infect flowers of grasses, transforming the ovary into a sphacelium and then to a sclerotium. The sclerotium and the disease caused by *Claviceps* are commonly referred to as ergot (Bove, 1970). *Claviceps* species are widely distributed and occur in temperate, arid, subtropical and tropical environments (Brady, 1962). Most species have a narrow host range of one to several host genera. Only one species, *C. purpurea* (Fr.) Tul., is known to have a wide host range, reported from over 100 genera of Pooideae (Brady, 1962; Farr et al., 1989). *Claviceps purpurea* has been suggested to be comprised of multiple cryptic species that may be distinguished on the basis of conidial morphology and host affiliation (Loveless, 1971). The ergot on rye is considered the type of *C. purpurea* since early descriptions specifically mentioned this host (Saccardo, 1883).

Claviceps purpurea has been reported as the causal agent of ergot of *Spartina* (Boyle, 1976; Gessner, 1977, 1978). Samuelson and Gjerstad (1966) were the first to suggest that the alkaloid profile of *Claviceps* from *Spartina* differed from those of *C. purpurea*. Eleuterius and Meyers (1977) documented the unique alkaloid profile of this ergot, which they denominated the "feather ergot". Sclerotia from the rye ergot contained alpha and beta forms of ergocryptine while the *Spartina* ergot contained only the beta form. Loveless (1971) and Pazoutová (2000) suggested larger conidial size as a characteristic of *Claviceps* on *Spartina anglica* Hubbard. To further evaluate the relationship of the *Spartina* ergot to *C. purpurea*, data were obtained on morphology, ecology and ITS1 sequences.

MATERIALS AND METHODS

Herbarium collections were obtained from the National Fungus Collection (BPI) in Beltsville, Maryland (Table 1). Sclerotia were collected from *Spartina alterniflora* Loisel. plants located on the banks of the South River in South River, New Jersey. Germination of sclerotia was facilitated by surface sterilization using 50% Clorox® for 5 min followed by 3 rinses with sterile water. Sclerotia were then placed on the surface of sterile sand in petri dishes. The sand was kept moist using distilled water until sclerotia germinated. The dishes containing these sclerotia were placed on a lab bench where they remained throughout their germination. The temperature in the lab was about 25C°. Ascospores were ejected onto glass slides for measurement and onto potato dextrose agar (PDA, Difco) plates for isolation into pure culture. Ascomatal and sclerotial tissues were fixed in 3% glutaraldehyde, postfixed in 1% osmium tetroxide and embedded in Quetol 651® (Electron Microscope Sciences, Ft. Washington, Pennsylvania). Thin sections of ascomata were cut with glass knives, mounted on glass slides, stained with aqueous aniline blue (0.1%), and photographed using a compound microscope. For rind measurements 10 sclerotia of each host, *Spartina alterniflora, Festuca rubra, Secale cereal, Leymus chiniensis and Lolium perenne,* were sectioned by hand using a metal razor, transferred to glass slides, and viewed and measured on a videoscope screen. Conidial measurements were taken by removing conidia from culture plates (PDA) and measuring under a compound microscope with an ocular micrometer.

Flotation experiments were conducted by placing sclerotia in a beaker of water. Density of fresh *Spartina* sclerotia was estimated by measuring the density of an alcohol – water mixture that had been adjusted to the point of equilibrium between the sclerotia and the solution. Sclerotia that were observed to sink were placed in a sodium chloride – water mixture adjusted to the point of equilibrium. Density of each mixture was measured by use of a density hydrometer. A long-term flotation experiment was conducted by agitating sclerotia in a tray of 1% saline water for 30 days. Sclerotia from *Secale cereale* L., *Leymus chinensis* (Trin.) Tzvelev, *Lolium perenne* L., and *Festuca rubra* L. were also included in this test.

Table 1: Collections of *C. p. spartinae* examined

Host	**BPI#**	**Collector**	**Date**	**Location**
S. alterniflora	634408	FR Fosberg	Oct. 1940	Bodie Island, N. Carolina
S. alterniflora	634409	JE Benedict	Oct. 1947	Lander, Maryland
S. alterniflora	634410	E Toole	Oct. 1933	Atlantic City, New Jersey
S. alterniflora	634411	JE Benedict	Nov. 1974	Terry's Creek, Georgia
S. brasiliensis	634415	FP Gallianl	Apr. 1943	Costa Martina, Uruguay
S. cynosuroides	634416	H Webber	Aug. 1889	Howard Co., Nebraska
S. cynosuroides	634417	B Thompson	Dec. 1920	Bay Co., Florida
S. foliosa	634418	A Carter	Nov. 1952	Richmond, Virginia
S. michauxiana	634423	HE Morris	Oct. 1912	Belgrade, Montana
S. patens	634427	JE Benedict	Sept. 1934	Valley Lee, Maryland
S. patens	634428	OE White	Oct. 1919	Seaport, Maine
S. patens	634429	DB Creager	Nov. 1935	Hyannis, Massachusetts
S. pectinata	634430	Hermann	Sept. 1965	Elkhorn, Canada
Spartina sp.	634402	OE White	Oct. 1909	Brookings, South Dakota
Spartina sp.	634400	JT Rogers	Nov. 1923	Charleston, South Carolina
S. stricta	634432	OE White	Dec. 1919	Searsport, Maine
S. stricta	634431	Unknown	Dec. 1887	Flatlands, Louisiana

DNA EXTRACTION AND SEQUENCING

Total genomic DNA from mycelium of *C. purpurea* from *S. alterniflora* was extracted from cultures grown on PDA overlaid with cellophane. Tissue was ground to fine powder in liquid N_2. DNA extraction was performed using the procedures of Lee and Taylor (1990). Successful PCR amplification resulted in a single DNA band corresponding to ~600 bp (ITS1, 5.8S ITS2 rDNA). Cycle sequencing reactions were performed using an Amplitaq FS Dye Deoxy Terminator Cycle Sequencing kit (Applied Biosystems Inc., Foster City, California). Reactions were run on a 373A DNA sequencer (Applied Biosystems Inc., Foster City, California). Other DNA sequences were obtained from GenBank, including *C. citrina* Pazoutová, Fucik, Leyva-Mir & Flieger from *Distichlis spicata* (L.) Greene (GenBank AJ000068), *C. africana* Freder., Mantel & De Milliano from *Sorghum sp.* Moench (GenBank AJ01784), *C. sorghicola* from *Sorghum* sp. (GenBank AJ011591), *C. purpurea* (Fr.: F) Tul. from *Lolium sp.* (L.) (GenBank AJ000069), *C. purpurea* from *Phalaris* sp. (L.) (GenBank AJ000070), *C. purpurea* from *Dactylis glomerata* (L.) (GenBank U57669), *Balansia claviceps* Speg. from *Panicum ghiesbrechtii* Fourn. (GenBank U89366), and *B. asclerotiaca* Henn. from *Orthoclada laxa* (GenBank U89368).

PHYLOGENETIC ANALYSIS

Alignment of sequences was accomplished using GCG (Genetics Computer Group, Madison, Wisconsin) program with default program options. Visual adjustments of aligned sequences were made to refine the alignment. To evaluate groupings, sequences were analyzed using PAUP 4.0 Beta version (Smithsonian Institution, Washington D.C.) on a Power Macintosh 9500/132. Maximum parsimony analysis of the aligned sequences was performed with alignment gaps treated as missing data. Heuristic searches were performed with the following options in effect: tree-bisection-reconnection, branch-swapping algorithm, random sequence additions option set to 100, collapse zero length branches to yield polytomies and save all minimal length trees (MULPARS) (Swofford, 1991). To measure relative support for the clades, 500 bootstrap replicates were performed. Bootstrap values were mapped onto the tree (Fig. 1) to show support for groupings. *Balansia claviceps* and *B. asclerotiaca* were included as outgroup.

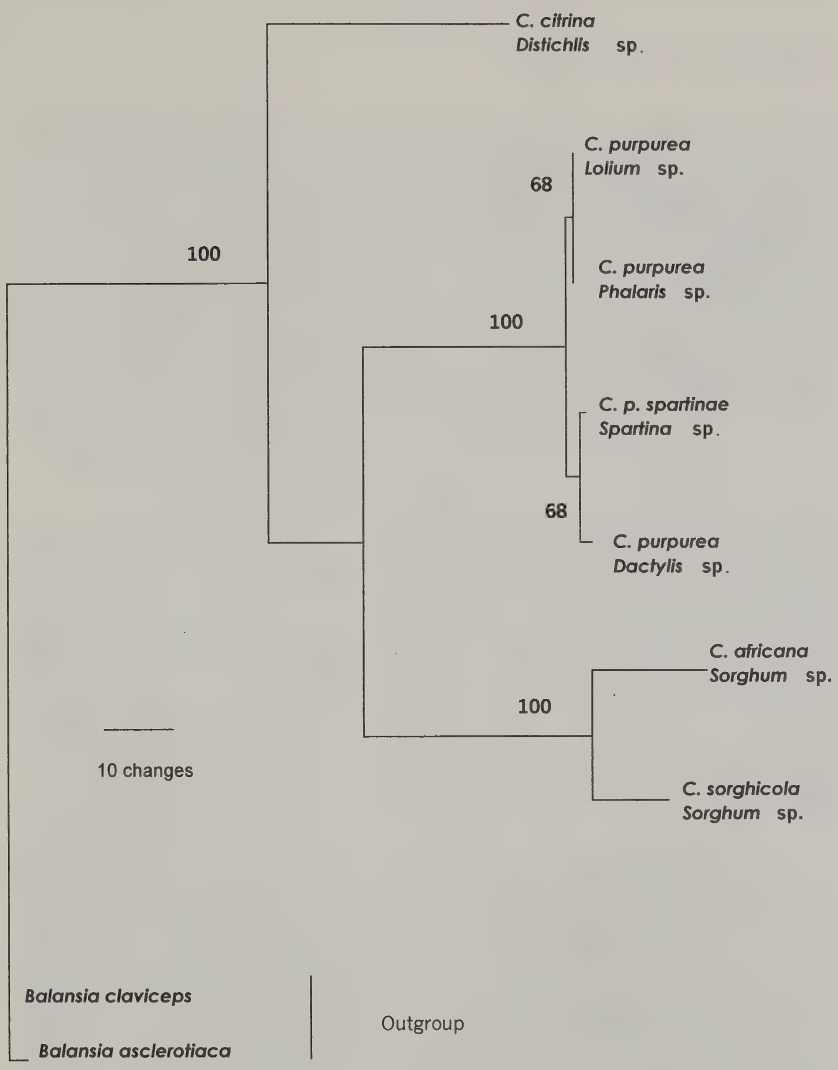

C. citrina Distichlis sp.
100
C. purpurea Lolium sp.
68
C. purpurea Phalaris sp.
100
C. p. spartinae Spartina sp.
68
C. purpurea Dactylis sp.
C. africana Sorghum sp.
100
C. sorghicola Sorghum sp.
10 changes
Balansia claviceps
Balansia asclerotiaca
Outgroup

Fig. 1. Tree resulting from maximum parsimony search of rDNA ITS1 sequences. (Length 201 steps; CI = 0.97; HI = 0.04; RI = 0.95). Bootstrap values (heuristic with 500 replicates) are mapped onto tree.

RESULTS

ASCOMATAL DEVELOPMENT

Sclerotia from *Spartina alterniflora* germinated after 30 days in moist sterile sand at room temperature (Figs. 2-6). Stipe elongation and perithecia formation were observed 2-3 days after germination (Figs. 4-6). Stroma formation begins with the emergence of a purplish-white cottony cushion on the surface of sclerotia. The purplish stipe then forms beneath the cushion and elongates as the cushion differentiates to form a roughly spherical cap or ascomatal head. The red ostiolar necks of perithecia are emergent from beneath the surface of the ascomatal head. Perithecia are obpyriform (Fig. 7) with ostiolar necks containing lateral periphyse (Fig. 8). Mature ascospores were discharged 4-5 days after germination of the sclerotium.

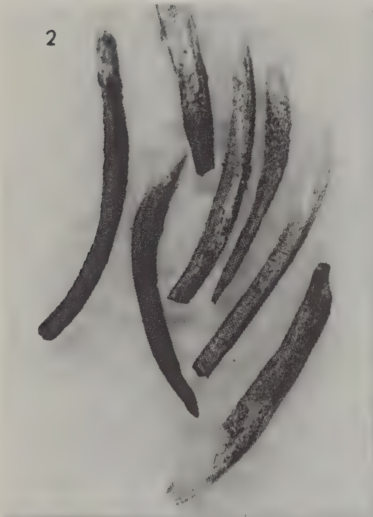
Table 2: Sclerotial characteristics

Host	**Size**	**Float**	**Rind thickness**	**Density**
Spartina alterniflora	17.2 ± 3.92 X 1.70 ± 0.56 mm	yes	87.2 ± 14.5 µm	0.90 g/cc
Secale cereale	6.83 ± 0.37 X 1.92 ± 0.19 mm	no	48.8 ± 8.97 µm	1.07 g/cc
Leymus chiniensis	5.86 ± 1.25 X 1.61 ± 0.39 mm	no	46.8 ± 10.5 µm	1.05 g/cc
Lolium perenne	7.93 ± 1.58 X 1.54 ± 0.35 mm	no	45.9 ± 9.14 µm	1.07 g/cc
Festuca rubra	6.21 ± 0.94 X 1.00 ± 0.00 mm	no	38.4 ± 7.42 µm	1.10 g/cc

CHARACTERISTICS OF SCLEROTIA

The rind of the sclerotia from *Spartina* was significantly ($P \geq 0.05$) thicker than that of the rye ergot (Table 2, Fig. 9, 12F). The rind contained an inner cellular melanized component and an outer region composed of inflated, often collapsed, cells that appeared to lack cytoplasmic content (Figs. 9, 12F). The rinds of sclerotia from the *Festuca rubra* ergot were seen to contain an acellular melanized component; an outer layer composed of inflated cells was not evident (Figs. 11, 12C).

Figs. 2-6. Sclerotia and ascomatal stromata. **2**. Sclerotia from *Spartina* showing subulate shape and lighter basal pigmentation, X 2. **3**. Clavate sclerotia of the *C. purpurea* from *Festuca rubra* (arrowheads) shown with a single larger subulate sclerotium from *Spartina*, X 2. **4** Ascomatal stroma of *C. purpurea* from *Spartina*, X 8. **5**. Ascomatal head showing numerous perithecia, X 27. **6**. Ascomatal stroma of the *C. purpurea* from *Spartina* showing bifurcation to form two ascomatal heads, X 17.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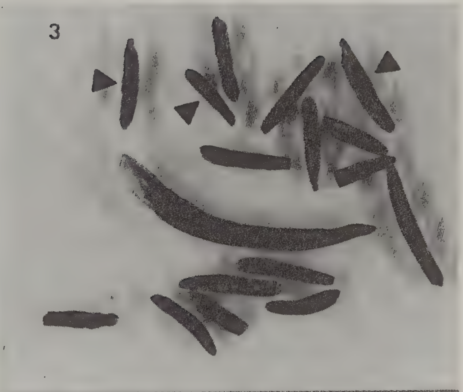
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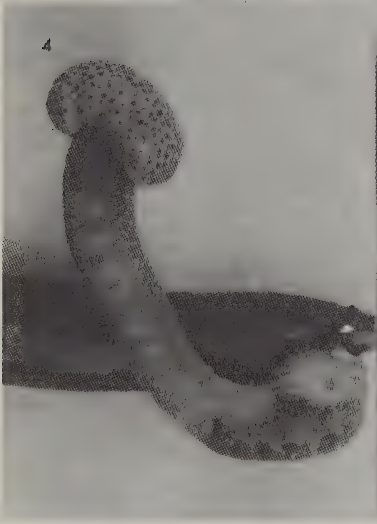
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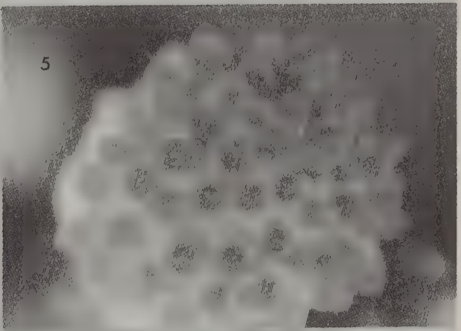
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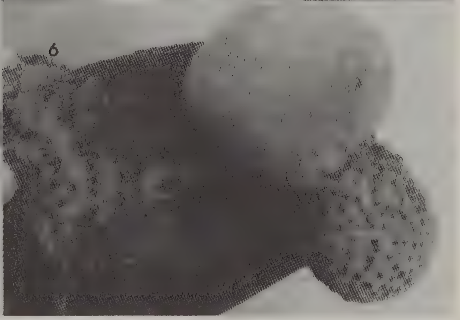
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Sclerotia of the *Spartina* ergot contain a large number of intercellular spaces (Fig. 10). Fewer intercellular spaces were observed in the sclerotia of the *Festuca* ergot (Fig. 11). In a flotation experiment, the sclerotia from *S. alterniflora* remained afloat during a 30 day long trial in agitated salt water. Removal of the rind did not effect the floatation of the sclerotia of the *Spartina* ergot. Sclerotia from *Secale cereale* L., *Leymus chinensis* (Trin.) Tzvelev, *Lolium perenne* L., and *Festuca rubra* L. sank in water (Table 2).

TAXONOMIC ANALYSIS

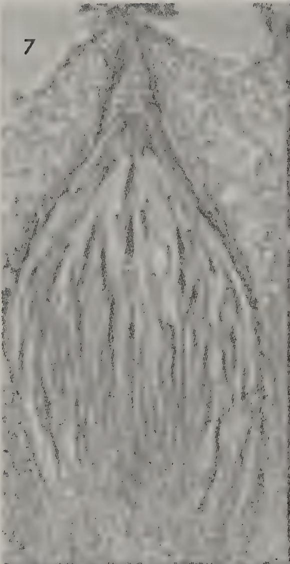
Analysis of the rDNA ITS1 sequences of several collections of *Claviceps* spp. demonstrated that the *Spartina* ergot grouped within the *C. purpurea* clade (100% bootstrap support). Pazoutová and Parberry (1999) demonstrated the utility of analysis of the rDNA ITS1 sequence to separate several species of *Claviceps*. It seems appropriate to weigh heavily the placement of the *Spartina* ergot within the phylogenetic species *C. purpurea*. However, several features of the *Spartina* ergot distinguish it from *C. p. purpurea* as exemplified by ergots from *Secale cereale* L., *Leymus chinensis* (Trin.) Tzvelev, and *Lolium perenne* L. (see Tanda, 1978; Table 2). Among the distinguishing features of the ergot from *Spartina* are: 1) thicker sclerotial rind, 2) numerous large intercellular spaces, 3) capacity to float, 4) larger conidia, 5) host range restricted to *Spartina*, 6) cold conditioning not required, and 7) unique alkaloid profile. It is the opinion of the authors that the many unique features of the ergot from *Spartina* and its adaptation to a maritime habitat are sufficient to consider this ergot as a unique variety of *C. purpurea*.

DESCRIPTION

Claviceps purpurea **var.** ***spartinae*** **R. Duncan & J. F. White,** ***var. nov.***

Sclerotiis 17.2 ± 3.9 mm longis, 1.7 ± 0.5mm latis, purpureo-brunneis vel atro-brunneis, intus albidis, subcurvatis, subulatatis; stromatibus simplex ad tetrafurcatus; stipite 4.6 ± 3.5 mm longo, 1.3 ± 1.7 mm lato, erecto vel subcurvato, brunneo-violaceo;

Figs. 7-11. Anatomy of ascomata and sclerotia of *C. purpurea*. 7. Vertical section of perithecium of the *C. purpurea* from *Spartina*, X 385. **8**. Section through ostiole of perithecium of *C. purpurea* from *Spartina* showing periphyses, X 1000. **9**. Section of sclerotium of *C. purpurea* from *Spartina* showing rind, X 560. **10**. Section through sclerotium of *C. purpurea* from *Spartina* showing large intercellular spaces (black dots), X 560. **11**. Section through sclerotium of *C. purpurea* from *Festuca rubra* showing thin rind (arrowheads) and small intercellular spaces (black dot), X 560.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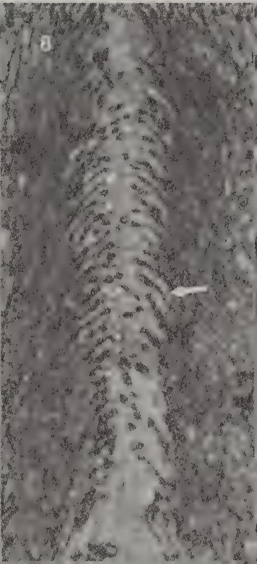
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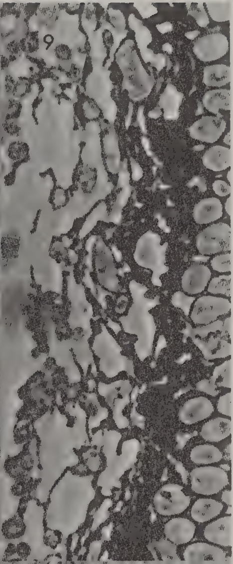
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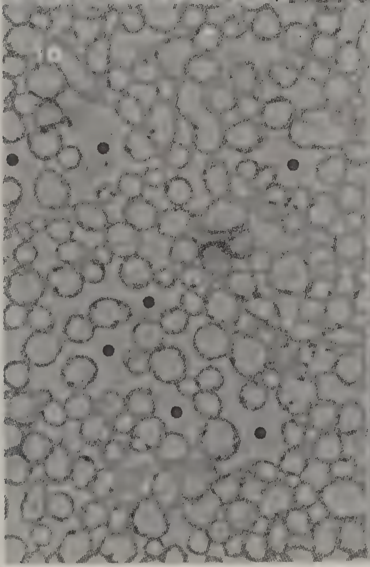
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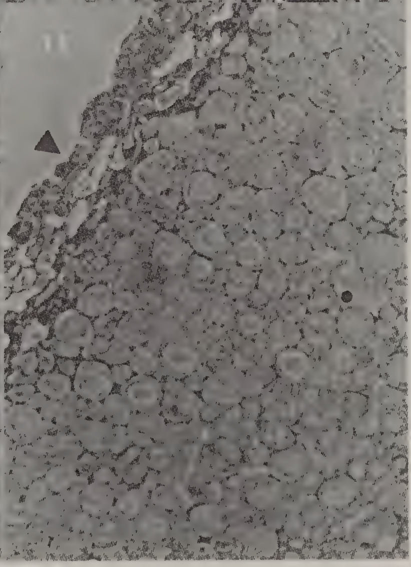
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capitulum 1.4 ± 0.5 mm diametro, globosum vel subglobosum, albidum, punctulatum con ostioli rubelli; peritheciis immersis, ovoideis, 144.2 ± 23.9 µm longis, 91.8 ± 11.2 µm crassis; ascis hyalinis, cylindraceis, flexuosis, in basi attenuatis, in apice rotundatis, octosporis 62.5 ± 1.0 µm longis, 2.6 ± 0 µm crassis; ascosporis hyalinis, filiformibus, 4 - 5 septata, 84.4 ± 4.5 µm longis, 0.8 ± 0 µm crassis. Anamorphus *Sphacelia segentum* Lèv.

Habitatum: in ovariis vivis *Spartina alterniflora* Loisel.

Type: *Claviceps purpurea var. spartinae* on *Spartina alterniflora*, on the banks of South River, South River, NJ, USA. R. A. Duncan, Nov. 1997. Rutgers University Mycological Herbarium RUTPP3419.

Sclerotia 17.2 ± 3.92 X 1.7 ± 0.5 mm, purple brown or dark brown, interior white, curved, often subulate, showing the capacity to float in fresh and salt water; stromata simple to four-forked; stipe 4.6 ± 3.5 X 1.25 ± 1.73 mm, straight or slightly curved, purple-brown; ascomatal head 1.3 ± 0.4 mm in diameter, globose to subglobose, white to slightly tan, punctate with reddish ostioles; perithecia immersed to exposed, ovoid, 144.2 ± 23.9 X 91.8 ± 11.2 µm; asci hyaline, cylindrical, flexuose, at base attenuate, at apex rounded with refractive tip, containing eight filamentous ascospores, 62.5 ± 0.9 X 2.6 ± 0 µm; ascospores hyaline, filiform, 4 - 5 septa, 84.4 ± 4.5 X 8 ± 0 µm. Anamorph: *Sphacelia segentum* Lév. Conidia, enteroblastic, cylindrical, uninucleate, 8.06 ± 1.8 X 4.12 ± 1.3 µm, occasionally septate in larger conidia; conidiogenous cells, phialidic, ampuliform, 2.9 ± 0.1 X 4.2 ± 0.2 µm, budding conidia apically, with thickened walls bordering conidiogenous locus.

DISCUSSION

Historically *Claviceps* species were defined based on host range and details of the stromata (Langdon, 1954). Loveless (1964) suggested size and shape of conidia may also be of value in species separation. More recently molecular phylogenetic analyses have played an important role in defining relations among taxa (Pazoutová and Parberry, 1999). In the case of *Claviceps* from *Spartina*, a suite of characteristics including physical, physiological, and molecular genetic differences can be applied to separate it

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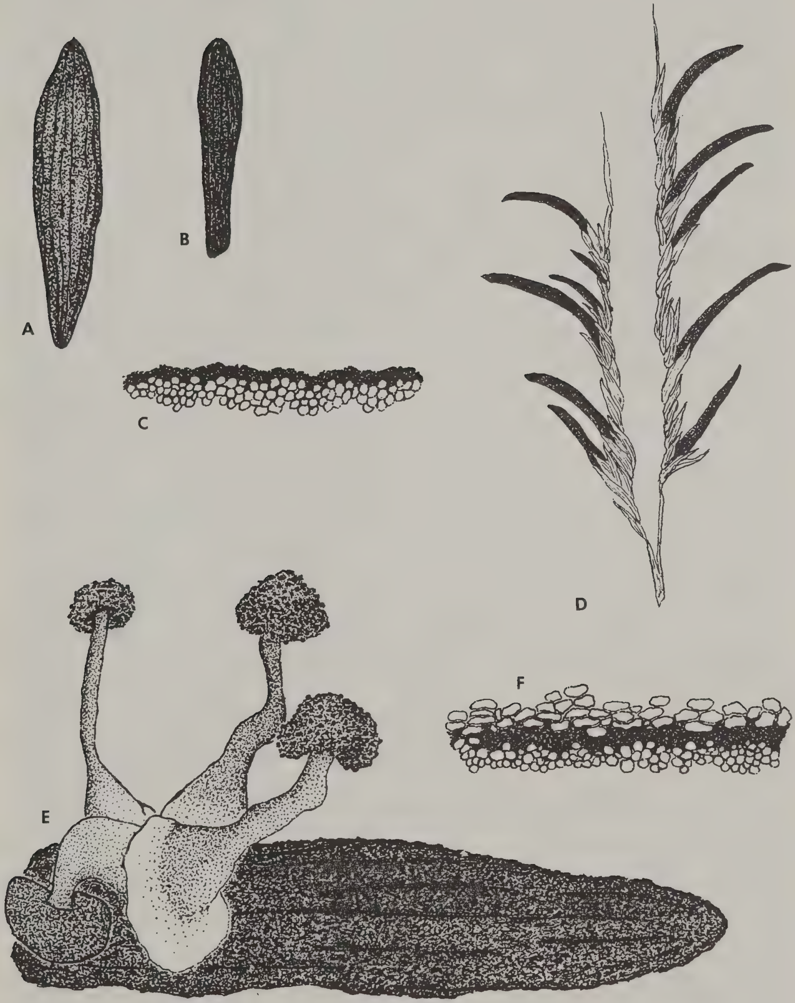
Fig. 12A-F ***C. purpurea.*** **A**, **B**. Sclerotia of *Claviceps purpurea* from *Festuca rubra*, X 4. **C**. Section through sclerotium of *C. purpurea* from *Festuca rubra* showing thin rind, X 100. **D**. Florets of *Spartina alterniflora* infected by *C. p. spartinae*, X4. **E**. Germinating sclerotium of *C. purpurea* from *Spartina* showing the rind composed of multiple layers, X 100.


A
B
C
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F

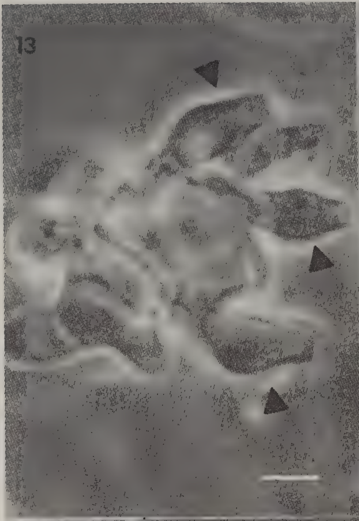
as a variety from *C. p. purpurea*. The physical properties of the sclerotia including the large intercellular spaces, which permit flotation, adapt it to the aquatic environment. The alkaloid profile, which differs from *C. p. purpurea,* suggests a physiology that differs from that variety. The lack of cold conditioning period indicates a further physiological separation from *C. purpurea* and also an adaptation to southern coastal waters where the cold conditioning period would likely not be met. Although the host range of *C. p. spartinae* has not been fully resolved it is likely restricted to *Spartina*. Althought *C. purpurea* has been assumed to infect *Spartina*, infection studies indicate otherwise (Mantel, 1969). In terms of host range, it is not unexpected that *C. p. purpurea* cannot infect *Spartina*. *Claviceps purpurea* var. *purpurea* is largely restricted to Pooid grasses; *Spartina* is a member of the Chloridoid group.

Tanda (1978, 1979) separated *Claviceps purpurea* into four varieties, including *C. p. purpurea*, *C. p. alopecuri* Tanda, *C. p. phalaridis* Tanda and *C. p. sasae* Tanda. Our use of anatomical features of sclerotia along with capacity for flotation to establish *C. p. spartinae* follows the precedent set by Tanda. Pazoutová (2000) separated *C. purpurea* into races based on alkaloid profiles and ecological specialization. The establishment of varieties to identify distinctive types that bear obvious close affinity to *C. purpurea* seems warranted and consistent with the development of a phylogenetic species concept.

Spartina spp. are important components of estuarine ecosystems. In many salt marshes, *S. alterniflora* is frequently the dominant plant species (Eleuterius and Meyers, 1974; Raybould et al., 1998). Eleuterius (1970) reported that 96% of the flowering culms of *S. alterniflora* bore florets infected with *C.p. spartinae*. This ergot thus is a very common parasite of *S. alterniflora* and has been reported to also infect *S. patens* (Ait.) Muhl. and *S. cynosuroides* (L.) Roth in North America, and *S. maritima* (M.A. Curtis) Fern in Argentina (Eleuterius and Meyers, 1977) and *S. anglica* in Great Britain (Raybould et al., 1998). We have further found this ergot on *S. brasiliensis* Rad. from Uruguay, and *S. foliosa* Trin., *S. michauxiana* A.S. Hitchc., *S. stricta* (Ait.) Roth, and *S. pectinata* Link from North America (Table 1).

The structure of sclerotia of *C. p. spartinae* appears to be a result of adaptation to its semi-aquatic grass hosts. Eleuterius and Meyers (1974) reported that sclerotia were often dislodged by wave action and transported with the tide before being deposited along the periphery of the marsh. Sclerotia of *C. p. spartinae* contain large intercellular spaces (Fig. 10). In contrast, sections of non-floating sclerotia from *C. p. purpurea* (*Festuca rubra*) (Fig. 11) revealed that such spaces are rare. The flotation capacity of sclerotia of *C. p. spartinae* may stem from gasses that may accumulate in intercellular

Figs.13–16. Conidia and conidiogenous cells of *Claviceps purpurea* from *Spartina*. 13. Conidiogenous cell showing ampuliform structure (Bar = 2µm). **14.** Conidia (Bar = 10µm) **15 - 16.** Conidia with conidiogenous cell indicated by arrow (Bar = 10µm).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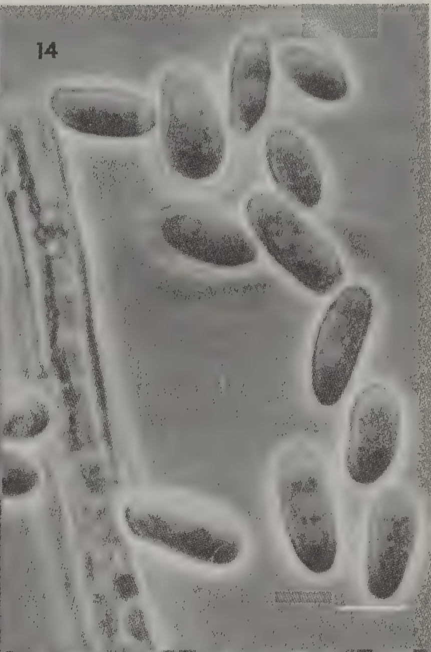
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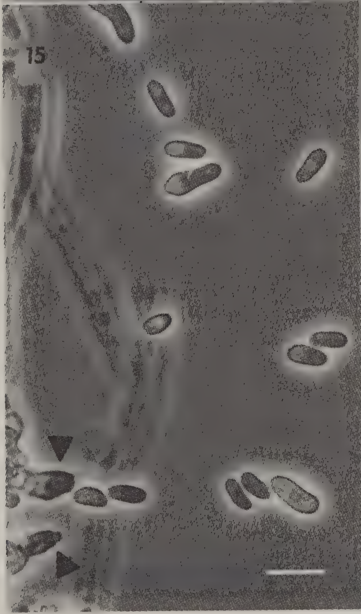
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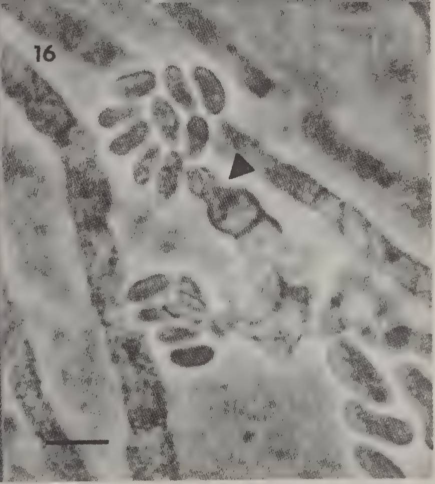
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spaces, and thus the tissues may in effect be aerenchyma. The larger size of sclerotia of *C. p. spartinae* may enhance their capacity for dispersal in water. The thicker rind of sclerotia of *C. p. spartinae* may provide them with added protection from salts that concentrate in the mud along the margins of estuaries where the sclerotia eventually lodge. The widespread distribution of *C. p. spartinae* in North America, South America, and Europe may be due to the long distance dispersal of sclerotia in ocean currents. In one flotation experiment, sclerotia of *C. p. spartinae* showed no evidence of losing the capacity to float even after 30 days of agitation in 1% salt water. Dispersal and survival in the marine environment must have been a significant component of the selective pressures that molded the divergence of *C. p. spartinae* from *C. p. purpurea.*

ACKNOWLEDGEMENTS

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SOME NEW SPECIES AND NEW RECORDS OF DISCOMYCETES IN CHINA. IX*

WEN-YING ZHUANG, ZHI-HE YU, YAN-HUI ZHANG, MING YE
Systematic Mycology & Lichenology Laboratory
Institute of Microbiology, Chinese Academy of Sciences, Beijing 100080, China

ABSTRACT: *Psilachnum hainanense* is described as a new species. Four taxa in the genera *Cistella*, *Perrotia*, *Proliferodiscus*, and *Vibrissea* are reported for the first time from China. Infraspecific variations among collections of six other discomycetes in tropical and subtropical regions are discussed.

KEY WORDS: Taxonomy, Tropical China, *Psilachnum hainanense*

In our studies on the Chinese discomycete flora, collections from tropical and subtropical areas of China were examined. A new species, *Psilachnum hainanense*, was encountered and is described. Four new records for China are reported, of which two possible new taxa are involved. Morphological diversities have been found in several previously recorded discomycetes from different localities and at different elevations, which are treated as infraspecific variations.

Measurements were carried out in cotton blue lactophenol and ascus iodine reaction was observed in the Melzer's reagent without KOH pretreatment except as otherwise mentioned.

TAXONOMY

Cistella cf. **hungarica** (Rehm) Raitv., Scripta Mycol. 8: 151, 1978. （参照）匈牙利小毛盘菌

Apothecia discoid, 0.6-1 mm diam, hymenium yellow, receptacle whitish, surface downy or pubescent; hairs subcylindrical at lower portion, slightly swollen at apex, granulate at upper portion and smooth-walled below, hyaline, 1-3-septate, up to 70 x 2.5-3.5 µm; ectal excipulum of textura prismatica, cells hyaline, thin-walled; medullary excipulum of textura intricata, hyphae hyaline; hymenium 45-50 µm thick; asci clavate to subcylindrical, 8-spored, with crozier at base, J+ in Melzer's reagent, 35-47 x 4.2-5 µm; ascospores rod-shaped, cylindrical-fusoid to clavate, unicellular,

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* Supported by the National Natural Science Foundation of China and Foundation of the Knowledge Innovation Program of the Chinese Academy of Sciences. E-mail: zhuangwy@sun.im.ac.cn

mostly with 2 small polar guttules, biseriate, 5-6.5(-7.5) x 1.4-2 μm; paraphyses subcylindrical, 1.8-2 μm wide.

Specimen examined: China. Hainan: Ledong, Jianfengling, alt. 1000 m, on a small twig, Z.H. Yu, W.Y. Zhuang & Y.H. Zhang 3788, 10 XII 2000, HMAS 78607.

Notes: The apothecial gross morphology of our fungus resembles, in some way, that of *Proliferodiscus* J. H. Haines & Dumont, but the distribution of granules on hair surface does not fit. Hairs of the Hainan collection possess a granulate upper portion and a smooth-walled basal part which are typical in *Cistella* Quél. Compared with existing species of the genus, the shape and size of asci and of ascospores and hair septation in our collection are similar to those of *C. hungarica* (Raitviir, 1970, 1978); the description of the latter differs in the shorter hairs 15-40 x 3-4 μm, shorter and wider asci 27-40 x 4-6 μm, and smaller apothecia 0.15-0.5 mm diam. HMAS 78607 might represent an undescribed taxon. Unfortunately, it contains very few apothecia, mostly immature, and is too scanty to be a type. It is tentatively treated as *Cistella* cf. *hungarica*.

Perrotia atrocitrina (Berk. & Broome) Dennis, Kew Bull. 17: 326, 1963. 黑黄钝囊盘菌

Apothecia discoid, sessile, 0.5-1 mm diam, hymenium olivaceous, olive-brown to dark brown, receptacle dirty yellow to pale brown, surface furfuraceous or hairy; hairs subcylindrical, pale yellow, closely septate, hair surface roughened to nearly smooth at and near margin, more or less granulate at apothecial base, 100-150 x 3.7-4.5 μm, walls 0.7-1.5 μm thick; ectal excipulum of textura prismatica at margin and upper flank, ca 25-45 um thick, cells pale yellow, thick-walled, 10-17 x 3-5 μm; medullary excipulum of textura intricata, ca 30-80 μm thick, hyphae subhyaline, thick-walled, somewhat gelatinous, 2-4 μm wide; hymenium 183-200 μm thick, with gelatinous matrix; asci clavate with a narrow base and truncate apex, 8-spored, J- in Melzer's reagent, (137-) 152-190 x 13-15 μm; ascospores vermiform, with 6-15 septa, 2-3-seriate, (24-) 28-45.5 x 4.8-6.5 μm; paraphyses filiform, slightly enlarged at apex, 1.2-1.7 μm wide.

Specimens examined: China. Hainan: Tongshi, Wuzhishan, alt. 1500-1700 m, on rotten bare wood, Y.H. Zhang, Z.H. Yu & W.Y. Zhuang 3873, 3874, 3879, 16 XII 2000, HMAS 81333, 81334, 81335; *ibid.* Z.H. Yu, Y.H. Zhang & W.Y. Zhuang 3883, HMAS 81336.

Notes: Compared with the type material from Sri Lanka (as Ceylon) on bare wood (Dennis, 1963), the Chinese collections have longer hairs (100-150 μm *vs.* 90 μm long) and wider ascospores (4.8-6.5 μm *vs.* 4-5 μm wide). These are certainly infraspecific variations.

Proliferodiscus dingleyi Spooner, Biblioth. Mycol. 116: 635, 1987. 丁氏层出盘菌

Apothecia discoid, a few proliferating, dried material 0.5-0.8(-1.2) mm in diam, stipitate, hymenium yellow, receptacle whitish to grayish, surface hairy, stipe base dark; hairs subcylindrical, undulate, 30-100 x 2.3-3 μm, walls slightly thickened, up to 0.8 μm thick, surface warted, warts 0.7-1.2 μm diam and 0.2-0.4 μm high; ectal excipulum of textura angularis to textura prismatica, 18-30 μm thick, cells subhyaline, 5-12 x 3-5.5 μm; medullary excipulum of textura intricata, ca 10-50 μm thick, hyphae hyaline, 1-2.5 μm wide; hymenium mostly 53-58 μm thick; asci cylindrical-clavate, J- in Melzer's reagent, 42-51 x 4.5-5.5 μm; ascospores elongate-ellipsoid, hyaline, non-septate, 6-7.8 x 1.4-1.8 μm; paraphyses subcylindrical to narrowly lanceolate, not exceeding the asci.

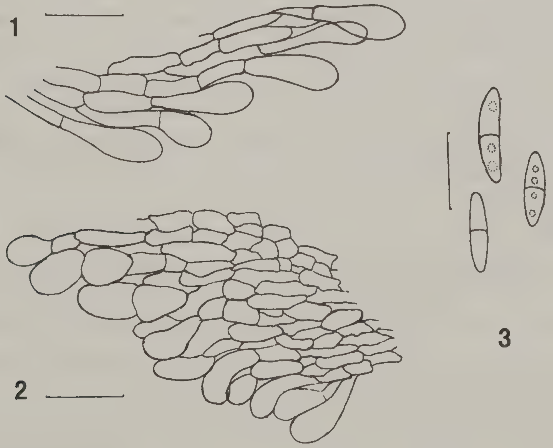
Specimen examined: China. Sichuan: Guan County, Qingchengshan, on stems of ?*Rubus* sp., Q.M. Ma *et al.* 106, 29 VI 1960, HMAS 30884.

Notes: *Proliferodiscus dingleyi* was originally recorded from New Zealand on bark of *Nothofagus* and rotten wood (Spooner, 1987). The Sichuan collection extends distribution of the fungus to southwestern China. The Chinese material has slightly wider asci, longer ascospores, and wider paraphyses and is on a different substrate.

Psilachnum hainanense W. Y. Zhuang, sp. nov. 海南短毛盘菌 (Figs. 1-3)

Ab *Psilachno woodwardio* apotheciis 0.2-1 mm diam; pilis apicaliter inflatis; ascis 45-70 x 4.6-7 μm; ascosporis fusoideis, uniseptatis, 4-guttulatis, irregulariter uniseriatis, 8.5-12 x 1.5-2.8 μm; paraphysibus subcylindricis differt.

Apothecia discoid, 0.2-1 mm in diam, sessile, hymenium yellow, light yellow, greenish yellow to brownish, receptacle concolorous or paler than hymenium, surface downy; hairs as short hyphal protrusions with a swollen apex, non-septate, hyaline, smooth- and thick-walled, up to 4 μm wide at apex and 2 μm below, 7-13 μm long, occasionally with a few delicate ones up to 26 x 1.3 μm; ectal excipulum of textura prismatica, 15-20 μm thick; medullary excipulum of textura intricata, 15-35 μm thick;



Figs. **1-3**. *Psilachnum hainanense*: **1**. Short hyphal protrusions on receptacle surface. **2**. Ectal excipular structure. **3**. Ascospores. **2** from HMAS 81609; **1**, **3** from HMAS 81341. Scale bars = 10 μm.

hymenium 70-85 μm thick; asci clavate, 8-spored, 45-70 x 4.6-7 μm; ascospores fusoid, sometimes slightly curved, 1-septate, hyaline, usually with 4 small guttules and 2 in each cell, irregularly uniseriate, 8.5-12 x 1.5-2.8 μm; paraphyses subcylindrical, 1.5-2 μm wide.

Holotype: China. Hainan: Qiongzhong, Limushan, alt. 700 m, on twig, Y.H. Zhang, W.Y. Zhuang & Z.H. Yu 3958, 18 XII 2000, HMAS 81341.

Paratypes: China. Hainan: Ledong, Jianfengling, alt. 1000 m, on rotten twig, W.Y. Zhuang, Y.H. Zhang & Z.H. Yu 3762, 10 XII 2000, HMAS 81608; Qiongzhong, Limushan, alt. 630 m, on herbaceous stems, Z.H. Yu, W.Y. Zhuang & Y.H. Zhang 4008, 19 XII 2000, HMAS 81609.

Etymology: The specific epithet refers to the locality of the fungus.

Notes: *Psilachnum* Höhn. was reviewed by Raitviir (1970) and its species were recorded by Dennis (1962, 1978), Graddon (1977, 1990), Sharma (1988), and Svrcek (1992) from different regions of the world. Among existing species, *P. woodwardiae* from India is the closest to our fungus, especially the shape, size, and septation of ascospores. The Indian fungus differs in smaller apothecia up to 375 μm in diam, smaller asci 30-50(-54) x 3.6-5.5 μm, eguttulate ascospores, wide paraphyses up to 4.5 μm wide, cylindrical hairs with 1-2 septa, and occurring on ferns (Sharma, 1988).

Vibrissea cf. **sporogyra** (Ingold) Sánchez, Mycologia 58: 734, 1966. （参照）旋孢水盘菌

Apothecia on white subiculum, pulvinate, 0.7-0.8 mm in diam, sessile and broadly attached, hymenium dirty orange, receptacle lighter than hymenium; ectal excipulum of textura angularis, tissues gelatinous, 15-40 μm thick; medullary excipulum of textura intricata, hyphae hyaline, 1-1.5 μm wide; hymenium ca 160 μm thick; asci subcylindrical, 8-spored, strongly thickened at apex, ca. 150-160 x 12-13 μm; ascospores cylindrical at upper portion, narrow at the lower end, with 20-32 or more septa, hyaline, 110-130 μm long, 3.5-3.7 μm wide in the upper portion and ca. 1.5 μm at lower end; paraphyses filiform, branched and deformed apically, irregularly undulate, 1-1.5 μm wide.

Specimen examined: China. Hainan: Ledong, Jianfengling, alt 1100 m, on a living leaf of an unidentified dicotyledon, W.Y. Zhuang, Y.H. Zhang & Z.H. Yu 3716, 9 XII 2000, HMAS 81343.

Notes: The apothecia of this fungus are pulvinate and seated on a white subiculum on a living leaf. Compared with the description of *Vibrissea sporogyra* Sánchez (1967), the Chinese collection differs in the somewhat larger fruitbodies, asci J- instead of J+ in Melzer's reagent, and shorter ascospores not twisted spirally within ascus. It might represent an undescribed taxon but the material contains only 4 apothecia and is too scanty to be a type.

INFRASPECIFIC VARIATIONS SHOWN BY A FEW DISCOMYCETES FROM TROPICAL AND SUBTROPICAL CHINA

Upon establishment, descriptions of the following discomycetes were based either on a single collection or on specimens from the same locality. Recently, specimens from different localities were examined, which gave better understanding of species concepts and revealed what we consider to be infraspecific variations. Updated information is provided for the taxa involved.

Albotricha guangxiensis W. Y. Zhuang, Mycotaxon 69: 360, 1998.

Specimens examined: China. Yunnan: Malipo, Laojunshan, alt. 1200 m, on culm of a large grass, W.Y. Zhuang & Z.H. Yu 3374, 10 XI 1999, HMAS 78140; Guangdong: Maoming, Dawuling, alt. 1400 m, on rotten culm of a large grass, W.Y. Zhuang & Z.H. Yu 2791, 22 X 1998, HMAS 78159; Hainan: Tongshi, Wuzhishan, alt. 1500-1800 m, on monocotyledon and bamboo, Z.H. Yu, W.Y. Zhuang & Y.H. Zhang 3869, 3890, 16 XII 2000, HMAS 76731, 81594; Jiangxi: Jinggangshan, alt. 800 m, on leaf sheath and culm of a large grass, W.Y. Zhuang & Z. Wang 1057, 23 X 1996, HMAS 81358.

Notes: The fungus was originally discovered from Guangxi (Zhuang, 1998). Recent collections on lager graminaceous plants were obtained from Dawuling Mountains of Guangdong, Hainan Island, Laojunshan Mountains of Yunnan, and Jinggangshan Mountains of Jiangxi at elevations between 800 m and 1400 m. Careful examinations indicated that these collections are very similar in shape of apothecia, anatomical structure, and shape of asci and of ascospores, while dimensions varied. The ascospore length seems to be the most variable character. For example, they measured 43-54 x 1.8-2.2 µm (Guangxi, holotype), 28-34 x 1.5-1.8 µm and 30-45 x 1.5-2.2 µm (Hainan, HMAS 76731, 81594), 28-43 x 1.5-1.9 µm (Guangdong, HMAS 78159), and 26-37 x 1.8-2 µm (Jiangxi, HMAS 81358).

Diagnostic features: Apothecia 0.4-1.3 mm diam, hymenium white, cream to light yellow, receptacle white, surface hairy; hairs needle-like, 40-150(-230) µm long, asci broadly clavate, pore J+ in Melzer's reagent, 64-89 x 7-10 µm, ascospores subcylindrical with the basal end slightly narrower, 0-3-septate, 26-54 x 1.5-2.2 µm, paraphyses narrowly lanceolate, 2-4 µm at the widest, exceeding the asci by 6-25 µm.

Dicephalospora pinglongshanica W. Y. Zhuang, Fung. Divers. 3: 190, 1999.

Specimen examined: China. Hainan: Lingshui, Diaoluoshan, 1050 m, on twigs, Y.H. Zhang, W.Y. Zhuang & Z.H. Yu 3817, 14 XII 2000, HMAS 81344.

Notes: One additional collection (HMAS 81344) was found. Its apothecia are much larger than those in the type and up to 1.2 mm in diam; excipular tissues are highly gelatinous; asci are J- in Melzer's reagent as shown in the holotype but longer and mostly 130-135 x 13-15 µm; and ascospores are larger and 24-32 x 5-7 µm; which broaden the ranges displayed in the holotype from Guangxi at a lower elevation (Zhuang, 1999).

Eleven *Dicephalospora* specimens were collected in our recent field work in the Hainan Island. Ten of them belong to *D. rufocornea* (Berk. & Broome) Spooner and one is *D. pinglongshanica*. The former is common throughout the tropical areas of China, where as the latter species is obviously rare but quite possibly occurs in other tropical regions as well.

Lambertella subrenispora Korf & W. Y. Zhuang, Mycotaxon 24: 367, 1985.

Specimen examined: China. Hainan: Tongshi, Wuzhishan, alt 1600 m, on petiole of a rotten leaf, Y.H. Zhang, W.Y. Zhuang & Z.H. Yu 3882, 16 XII 2000, HMAS 81357.

Notes: The fungus was first recorded as *Lambertella* taxonomic sp. from India by Arendholz & Sharma (1984), then named and described based on Japanese material by Korf & Zhuang (1985). A recent collection (HMAS 81357) extends the known distribution to tropical China. Information about apothecial gross morphology in fresh condition and ascus iodine reaction of the species can now be updated. The apothecia are discoid, up to 2 mm in diam, and short- to long-stalked; when fresh the hymenium is light pink to reddish orange and receptacle is concolorous and with surface downy to finely scaly. The ascus pores are either obviously blue in Melzer's reagent without KOH pretreatment as shown in the Indian and Chinese materials, or J- without KOH pretreatment and J+ after KOH treatment in the Japanese collection. Spore size seems stable in collections from different geographical regions, 11-12.5 x 4.5 µm (India), 11-13 x 4.8-6.4 µm (Japan), and 10-12 x 5 µm (China).

Lasiobelonium guangxiense W. Y. Zhuang, Mycotaxon 69: 370, 1998.

Specimens examined: China. Yunnan: Simao, alt. 1350 m, on small rotten twig, W.Y. Zhuang & Z.H. Yu 2899, 12 X 1999, HMAS 78058; Guangdong: Fengkai, Heishiding, alt. 300 m, on small twig, W.Y. Zhuang & Z.H. Yu 2850, 27 XII 1998, HMAS 81371.

Notes: HMAS 78058, a recent collection on a small twig from Simao, Yunnan, has smaller apothecia 0.3-0.6 mm in diam, wider asci 105-115 x 17-19 µm, and shorter and broader ascospores 20-24 x 6.5-8 µm than those in the holotype from Damingshan Mountains, Guangxi (Zhuang, 1998). The apothecia of HMAS 81371 from Mt. Heishiding, Fengkai, Guangdong possess a greenish yellow hymenium, vinaceous receptacle, much longer asci 125-142 x 16.5-18 µm, and longer ascospores 25-33 x 5.8-7.3 µm. The dimensions of the species should be re-written as apothecia 0.3-0.9 mm in diam, asci 98-142 x 13-19 µm, and ascospores 20-33 x 5.5-8 µm. The light brown, 4-celled ascospores constricted at septa is probably the most diagnostic feature of the fungus.

Parachnopeziza guangxiensis W. Y. Zhuang & Korf, Mycotaxon 69:371, 1998.

Specimen examined: China. Guangdong: Maoming, Dawuling, alt. 1400 m, on head of a graminaceous plant, W.Y. Zhuang & Z.H. Yu 2808, 22 X 1998, HMAS 75554.

Notes: The asci and ascospores of HMAS 75554 from Guangdong Province are much longer than those of the holotype (Zhuang, 1998), 74-97 x 9-11.5 µm *vs*. 62-74 x 8.5-11 µm and 30-42 x 2.6-3 µm *vs*. 30-35 x 2.7-3 µm, respectively.

Rutstroemia dabaensis W. Y. Zhuang, Mycotaxon 61: 10, 1997.

Specimen examined: China. Yunnan: Jizushan, on a tree, C.C. Chou 170, 18 IX 1938, HMAS 17083.

Notes: HMAS 17083 was collected sixty years ago in Yunnan Province and filed under *Helotium* sp. Its anatomic structure is typical *Rutstroemia* P. Karst. The small ascospore size recalls those of *R. dabaensis* known previously only from type locality, Wuxi, Sichuan Province (Zhuang, 1997). The Yunnan collection has larger apothecia, a thicker hymenium, and J- asci in Melzer's reagent which are longer than those in the holotype and paratypes. The fungus might be common in southwestern China. The updated diagnosis of the fungus is as follows: Apothecia 1-5 mm diam, hymenium orange to yellow when fresh, stipitate, stipe base very dark; ectal excipulum, 25-50 μm thick, tissues highly gelatinous, cells thick-walled and refractive; medullary excipulum 50-350 μm thick; hymenium 83-100 μm thick; asci either J+ or J- in Melzer's reagent, 71-95 x 4-6.5 μm; ascospores 5-8.5 x 2.5-3.5(-3.7) μm; on woody substrates.

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RE-EXAMINATIONS OF HELOTIUM AND HYMENOSCYPHUS (HELOTIALES, HELOTIACEAE): SPECIMENS ON DEPOSIT IN HMAS

YAN-HUI ZHANG and WEN-YING ZHUANG*
Systematic Mycology and Lichenology Laboratory, Institute of Microbiology
Chinese Academy of Sciences, Beijing 100080, China

Abstract: Specimens deposited in HMAS under the generic names *Helotium* and *Hymenoscyphus* were re-examined. Twelve taxa of *Hymenoscyphus* were identified according to modern species concepts. Other discomycetes observed are members of *Bisporella*, *Calycellina*, *Calycina*, *Ciboria*, *Crocicreas*, *Dicephalospora*, and *Lanzia*. *Hymenoscyphus sinicus* is described as a new species. Three new records for China were reported.

Key words: China, Discomycetes, *Hymenoscyphus sinicus*, Taxonomy

As Donk pointed out in 1962, *Helotium* Fr. 1849 is a later homonym of *Helotium* Tode 1790. Dennis (1964) transferred a fair number of species assigned to *Helotium* Fr. to *Hymenoscyphus* Gray, now commonly accepted by mycologists around the world. Research of *Hymenoscyphus* in China began in the 1930's when the generic name *Helotium* Fr. was used. Teng (1934) reported the first 5 species. Ou (1936) added 5 more taxa. Sixteen species of *Helotium* were recorded up to the early 1980's (Teng, 1963; Tai, 1979; Zang, 1983). In later studies, the generic name *Hymenoscyphus* has been accepted. Zhuang (1998) listed 15 taxa previously studied by Korf & Zhuang (1985), Zhuang & Korf (1989), Bi *et al*. (1990), Zhuang (1995), Wu *et al*. (1996), and Zhuang & Wang (1998). Recently, six species were found from the Changbai Mountains (Yu *et al*., 2000). This study is based on the dried herbarium specimens of *Helotium* and *Hymenoscyphus* on deposit in the Herbarium Mycologicum Instituti Microbiologici Academiae Sinicae (HMAS). Longitudinal sections were made with freezing microtome. Microscopic slides were mounted in cotton blue lacto-phenol and Melzer's reagent. New records for China are marked with an asterisk (*) in this paper.

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* Author for correspondence. zhuangwy@sun.im.ac.cn

Species Accepted in *Hymenoscyphus*

Hymenoscyphus caudatus (P. Karst.) Dennis, Persoonia 3: 76, 1964.

Specimens examined: on leaf veins, Liuba, Shaanxi, alt. 950 m, 21 IX 1991, W.Y. Zhuang (852), HMAS 61875; on herbaceous plant part, Tianhuashan, Foping, Shaanxi, alt. 1300 m, 26 IX 1991, W.Y. Zhuang (887), HMAS 61876; on culms of monocotyledon, Bailang, Inner Mongolia, alt. 1350 m, 18 VIII 1991, W.Y. Zhuang (678), HMAS 69618.

Notes: The Chinese collections fit the morphology of material from Europe and South America reported by White (1943), Dennis (1956), and Dumont (1982). The tropical American collections have larger asci [(90-)105-140(-150) x 8-12(-15) μm] (Dumont, 1982).

HMAS 69618 is different from the other two Chinese collections in slightly thickened (up to 2.5 μm thick) and refractive cell walls in the ectal excipulum and 2-6-guttulate ascospores.

*****Hymenoscyphus*** cf. ***consobrinus*** (Boud.) Hengstm., Persoonia 12: 489, 1985. （参照）相关膜盘菌

Apothecia discoid, 2-4.5 mm in diam, long stipitate, stipe up to 8 mm long when dry, hymenium yellow to orange-red when fresh, drying orange-red to yellow, receptacle yellow; stipe pale to light yellow, with whitish hyphae at the base. Ectal excipulum of textura prismatica, 35-63 μm thick, cells 6-20 x 5-13 μm; covering layer of one to several cell layers. Medullary excipulum of textura intricata, hyphae 1-4 μm wide. Asci cylindric-clavate, 8-spored, arising from croziers, J+ in Melzer's reagent, as two blue lines, 98-120 x 8-10 μm. Ascospores ellipsoid, very slightly narrower at one end, with 2-3 large guttules, non-septate, irregularly uniseriate to biseriate, 12-18 x 4-5(-6) μm. Paraphyses filiform, septate, 1.5-2.5 μm thick at apex.

Specimens examined: on stem base of *Rhododendron* sp., Xiangcheng, Sichuan, alt. 4500 m, 30 VI 1998, Z. Wang (0002), HMAS 75931; on dead wood, Daocheng, Sichuan, alt. 4000 m, 2 VII 1998, Z. Wang (0015), HMAS 75934.

Notes: The two collections differ from *Hymenoscyphus consobrinus* (Lizon, 1992) by the larger asci [98-120 x 8-10 μm *vs.* 85-95 x 6.5-7.5(-9) μm] and broader, non-septate, and ellipsoid instead of fusoid ascospores.

Hymenoscyphus epiphyllus (Pers.: Fr.) Rehm in Kauffman, Pap. Michigan. Acad. Sci. 9: 177, (1928) 1929.

Specimen examined: on fallen leaves of *Betula* sp., Arxan, Inner Mongolia, alt. 1210 m, 14 VIII 1991, W.Y. Zhuang (622), HMAS 61894.

Hymenoscyphus fructigenus (Bull.: Fr.) Gray, Nat. Arrang. Brit. Pl. 1: 673, 1821.

Specimens examined: on rotten seeds of *Quercus* sp., Baihuashan, Beijing, alt. 1400 m, 19 IX 1995, W.Y. Zhuang & Z. Wang (1233), HMAS 71816; on seeds of *Quercus* sp., Baihuashan, Beijing, alt. 1400 m, 20 IX 1995, W.Y. Zhuang & Z. Wang (1259), HMAS 71817; on rotten seeds of *Quercus* sp., Donglingshan, Beijing, 19 VIII 1998, Z. Wang (0264), HMAS 75893.

Notes: The collections from Beijing match most of the features of this species described by Dennis (1956, 1968) except that the stipe and asci are shorter. HMAS 75877 on rotten wood from Donglingshan, Beijing has shorter asci and ascospores and somewhat thick-walled cells in the ectal excipulum. We treated it as *Hymenoscyphus* cf. *fructigenus*.

Hymenoscyphus fucatus (W. Phillips) Baral & Hengstm., Hengstmengel, Persoonia 16: 193, 1996. 双极毛膜盘菌

Specimens examined: on herbaceous stem, Tewo, Gansu, alt. 2600 m, 11 IX 1992, W.Y. Zhuang (1017), HMAS 61883; on rotten twigs, Kangding, Sichuan, alt. 3500 m, 28 VIII 1997, Z. Wang (2178), HMAS 75902.

Notes: The Chinese collections has slightly shorter ascospores [21-28.5 x 4-6 μm *vs*. 24-34 x 5-6.8 μm and (23-)25-31(-35) μm] (White, 1944; Dennis 1956; Hengstmengel, 1996). The fungus was previously recorded as *Hymenoscyphus scutulus* (Pers.: Fr.) W. Phillips var. *fucatus* W. Phillips (Zhuang, 1995). Hengstmengel (1996) raised the variety to species level.

Hymenoscyphus immutabilis (Fuckel) Dennis, Persoonia 3: 76, 1964.

Specimens examined: on rotten leaves of *Populus* sp., Baihuashan, Beijing, 20 IX 1995, W.Y. Zhuang & Z. Wang (1251, 1273, 1274), HMAS 71806, 71808, 71809; on rotten leaves, Baihuashan, alt. 1400 m, Beijing, 20 IX 1995, W.Y. Zhuang & J.Y. Zhuang (1275), HMAS 71807; on rotten leaves, Baihuashan, Beijing, 19 IX 1995, W.Y. Zhuang & Z. Wang (1230), HMAS 71810; on rotten leaves, Baihuashan, alt. 1400 m, Beijing, 19 IX 1995, W.Y. Zhuang & C.L. Fu (1265), HMAS 71811.

Hymenoscyphus lasiopodium (Pat.) Dennis, Persoonia 2: 190, 1962.

Specimens examined: on dead root of *Carex* sp., Tanzhesi, Beijing, 8 X 1988, R.P. Korf & W.Y. Zhuang (465), HMAS 57692; on dead root of *Carex* sp., Baihuashan, Beijing, alt. 1200 m, 18 IX 1995, W.Y. Zhuang & Z. Wang (1204, 1205, 1196, 1195), HMAS 71803, 71804, 71805, 71819; on dead root of *Carex* sp., Baihuashan, Beijing, alt. 1400 m, 19 IX 1995, Z. Wang & W.Y. Zhuang (1221), HMAS 71820; on dead root of *Carex* sp., Baihuashan, Beijing, alt. 1400-1600 m, 20 IX 1995, W.Y. Zhuang & Z. Wang (1255, 1271), HMAS 71821, 71822; on dead root of *Carex* sp., Donglingshan, Beijing, 18 VIII 1998, Z. Wang (0242), HMAS 75878; on dead root of *Carex* sp., Donglingshan, Beijing, alt. 1100 m, 19 VIII 1998, Z. Wang (0261), HMAS 75880.

Notes: Compared with the South American material (Dumont, 1982), the Chinese collections occurred on dead roots of *Carex* sp. from Beijing and have much longer asci [120-180(-200) x 7.5-10(-12) μm *vs*. (90-)110-115(-130) x 6-8(-10) μm] and shorter and broader cells in the ectal excipulum (5-33 x 4-17 μm *vs*. 10-40 x 8-15 μm). HMAS 75878 and HMAS 75880 have non-septate ascospores that are possibly young.

****Hymenoscyphus menthae*** (W. Phillips) Baral in Baral & Krieglsteiner, Beih. Z. Mykol. 6: 131, 1985. 薄荷膜盘菌

Dried apothecia discoid, stipitate, 0.1-0.3 mm in diam, stipe 0.5-0.8 mm long, hymenium light yellow to light brown, receptacle light yellow to light brown, stipe cream to light yellow, red-brown at the base. Ectal excipulum of textura prismatica, 18-40 μm thick, cells 3-17 x 2-8 μm; covering layer of 1-3 cell layers. Medullary excipulum of textura intricate to textura porrecta, hyphae 1-4 μm wide. Hymenium

60-105 µm thick. Asci cylindric-clavate, 8-spored, J+ in Melzer's reagent, as two blue lines, 67-88(-112) x 6-8 µm. Ascospores elliptic-fusoid, with 1-3 large guttules, non-septate, irregularly biseriate, 14-18 x 3.5-4.3(-5) µm. Paraphyses filiform, 1-3 µm thick at apex.

Specimens examined: on a stem, Qingchengshan, Sichuan, 18 IX 1981, R.Y. Zheng & R.P. Korf (2388), HMAS 51841; on stem of *Polygonum cuspidatum* Sieb. & Zucc., 19 IX 1981, R.Y. Zheng & R.P. Korf (2413), HMAS 51842.

Notes: The Chinese collections were previously reported as *Hymenoscyphus scutulus* var. *solani* (P. Karst.) S. Ahmad (Korf & Zhuang, 1985). According to Hengstmengel (1996), *H. menthae* is the correct name for the fungus.

****Hymenoscyphus*** cf. ***populneus*** (Velen.) Svrček, Sborn. Nár. Muz. Praze 40B(3-4): 170, (1984) 1985. （参照）杨膜盘菌

Apothecia discoid, margin lower than hymenium, subsessile to short-stipitate, 1.5 mm in diam, hymenium yellow when fresh, light yellow to red brown when dry, drying receptacle whitish. Ectal excipulum of textura prismatica, 17-65 µm thick, with short hairs on receptacle surface, cells 13-18 x 3-5.5 µm. Medullary excipulum of textura intricata, 12-113 µm thick, hyphae 1-6 µm wide. Hymenium 62-88 µm thick. Subhymenium 0-30 µm thick. Asci cylindric-clavate, 8-spored, J+ in Melzer's reagent, as two blue lines, 46-55 x 5-5.5 µm. Ascospores ellipsoid to broadly fusoid, with 2(-4) polar guttules, non-septate, irregularly uniseriate to biseriate, 5.5-8 x 1.7-2.3 µm. Paraphyses filiform, 1-2 µm thick at apex.

Specimen examined: on rotten leaves of *Populus* sp., Donglingshan, Beijing, alt. 1100 m, 18 VIII 1998, Z. Wang (0240), HMAS 75881.

Notes: Compared with *Helotium populneum* Velen. (Velenovsky, 1947) from the former Czechoslovakia, our fungus has shorter ascospores and short-stipitate, yellow instead of pure white apothecia.

Hymenoscyphus sclerogenus (Berk. & M. A. Curtis) Dennis, Persoonia 2: 190, 1962.

Specimen examined: on cane of *Rubus* sp., E'mei Mountain, 25 VI 1983, W.Y. Zhuang (55), HMAS 45092.

Hymenoscyphus scutulus (Pers.: Fr.) W. Phillips, British Discom. p. 137, 1887.

Specimens examined: on herbaceous stem, Bailang, Inner Mongolia, alt. 1350 m, 18 VIII 1991, W.Y. Zhuang (679, 681), HMAS 61879, 61880; on herbaceous stems, Tewo, Gansu, alt. 2600 m, 11 IX 1992, W.Y. Zhuang (1018), HMAS 61881; on herbaceous stem, Huangshan, Anhui, alt. 1300-1700 m, 27 IX 1993, Y.R. Lin, Y. Wang, W.Y. Zhuang, S.M. Yu & W.J. Wu (1119), HMAS 61882.

Hymenoscyphus sinicus W.Y. Zhuang & Y.H. Zhang, **sp. nov**. 中华膜盘菌 (Figs. 1-3)

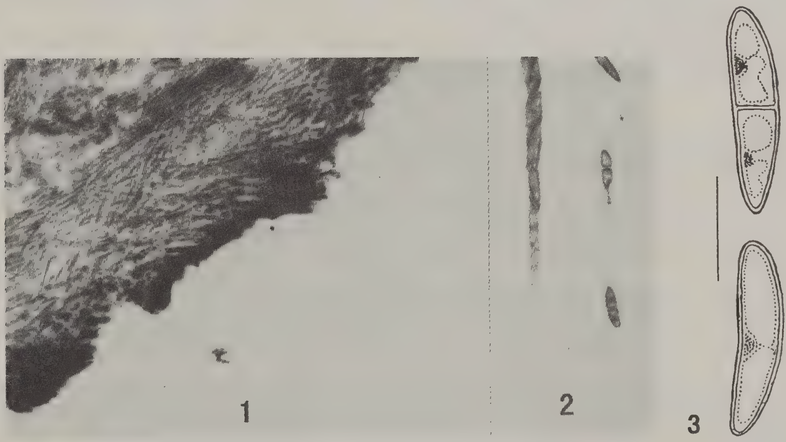
Ab *Hymenoscypho caudato* apotheciis magnis, 1-6 mm diam; ascis longis, 125-175 x 8-10(-12.5) µm, ascosporis 0-1-septatis, (16-)18-26 x (4.1-)4.5-5.5(-6) µm differt.

Apothecia discoid, 2-6 mm in diam, stipitate, stipe 1-7.5 mm long when dry, hymenium yellow to dirty yellow when fresh, yellow to brown when dry, receptacle whitish to yellow-orange when dry. Ectal excipulum of textura prismatica, 37-108 µm thick, cells 5-33 x 6-15 µm, cell walls slightly thickened; covering layer of 0-3 hyphal layers. Medullary excipulum of textura intricata, hyphae hyaline, 2-5 µm wide. Hymenium (125-)210-275 µm thick. Asci cylindric-clavate, 8-spored, arising from croziers, J+ in Melzer's reagent, pore walls bluing as two lines, 125-175 x 8-10(-12.5) µm. Ascospores fusoid to scutuloid, with 2-4 large guttules or multiguttulate, 0-1(-2)-septate, irregularly uniseriate to biseriate, (16-)18-26 x (4.1-)4.5-5.5(-6) µm. Paraphyses filiform, 1-3 µm wide.

Holotype: on rotten twigs, Baihuashan, Beijing, China, alt. 1400 m, 19 IX 1995, W.Y. Zhuang & Z. Wang (1213), HMAS 71818.

Paratypes: on ?root, Zhouqu, Gansu, China, alt. 2400 m, 3 IX 1992, W.Y. Zhuang (929), HMAS 69617; on rotten wood, Donglingshan, Beijing, China, alt. 1100 m, 20 VIII 1998, Z. Wang (0279), HMAS 75876.

Notes: The new species is similar to *Hymenoscyphus caudatus* in ascospore shape and size but differs obviously from the latter in large cells and somewhat gelatinized tissues in the ectal excipulum, longer asci (85-95 x 8-10 µm *vs*. 125-175 x 8-10(-12.5) µm), much larger apothecia (1-6 mm diam *vs*. 0.75-1 mm diam), and occurrence on woody substrates instead of leaf parts or herbaceous stems (Dennis, 1956; Dumont, 1982). Several other species possessing scutuloid ascospores in the genera *Hymenoscyphus*, *Lambertella* Höhn., and *Lambertellinia* Korf & Lizon (Korf & Lizon, 1994; Hengstmengel, 1996; Zhuang, 1999) were also compared. *H. sinicus* is distinctive in spore morphology, excipular structure, and apothecial dimension.



Figs. **1-3**. *Hymenoscyphus sinicus*: **1**. Ectal excipular structure. **2**. An ascus and three ascospores. **3**. Ascospores in a higher magnification. All from holotype. **1-2** x 315, **3** scale = 10 µm.

Species Belonging to Other Genera

Bisporella citrina (Batsch: Fr.) Korf & S.E. Carp., Mycotaxon 1: 58, 1974.

Specimens examined: On rotten wood, Jiabigou, Miyaluo, Sichuan, alt. 2850 m, 23 IX 1960, C.M. Wang, Y.X. Han & Q.M. Ma (1317), HMAS 30480; on mossy wood, Hebei, S.C. Teng (489) HMAS 33617; on dead twigs in bamboo forest, Jinzhongshan, Longlin, Guangxi, alt. 1700 m, 20 X 1957, L.W. Xu (125), HMAS 33618; on dead twigs, Lingle, Guangxi, alt. 1000 m, 11 X 1957, L.W. Xu (1153), HMAS 33619; on rotten wood, Laoshan, Lingle, Guangxi, alt. 1300 m, 15 XII 1957, L.W. Xu (368), HMAS 33717.

Bisporella cf. **citrina**

Specimens examined: on mossy wood, Miyaluo, Sichuan, 29 VII 1958, Y.L. Hu (98), HMAS 24098; on rotten wood of *Larix.* sp., Nantianmen, Taibaishan, Shaanxi, alt. 3000 m, 2 VIII 1963, Q.M. Ma & Y.C. Zong (2723), HMAS 33516; on rotten wood of broad-leaved trees, Xiaoxihe, Ledu, Qinghai, alt 2850 m, 10 IX 1959, J.C. Xing & Q.M. Ma (1569), HMAS 33623; on rotten wood, Wulingshan, Hebei, 9 IX 1958, K.G. Ji (176), HMAS 33624; on mossy wood in bamboo forest, Jinzhongshan, Longlin, Guangxi, alt. 1700 m, 20 X 1957, L.W. Xu (107), HMAS 33740; on rotten wood, Jinzhongshan, Longlin, Guangxi, alt. 1720 m, 25 X 1957, L.W. Xu (401), HMAS 33741; on rotten wood, Jinzhongshan, Longlin, Guangxi, alt. 1600 m, 19 X 1957, L.W. Xu (048), HMAS 33744.

Notes: The above collections have narrower asci and shorter ascospores than those of *Bisporella citrina* (Dennis, 1956). A *Cystodendron* stage was not found.

Calycellina populina (Fuckel) Höhn., Akad. Wiss. Wien Sitzungsber., Math. -Naturwiss. Kl., Abt.1, 127: 601, 1918.

Specimen examined: on rotten leaves, Huang'antuo, Baihuashan, Beijing, 26 IX 1956, Y.C. Wang, L.W. Xu & S.J. Han (223), HMAS 19697.

Calycina herbarum (Pers.: Fr.) Gray, Nat. arr. Brit. pl. 1: 669, 1821.

Specimens examined: on herbaceous stem, Yinshengou, Ledu, Qinghai, alt. 2600 m, 9 IX 1959, J.C. Xing & Q.M. Ma (1541), HMAS 31241; on herbaceous stem, Changbaishan, Antu, Jilin, alt. 1280 m, 20 VIII 1960, Y.C. Xiang, J.R. Chen & F.S. Yuan (880), HMAS 30751.

Ciboria peckiana (Cooke) Korf, Phytologia 21: 203, 1971.

Specimen examined: on rotten wood, Wuchongxiang, Longlin, Guangxi, alt. 1000 m, 31 X 1957, L.W. Xu (638), HMAS 33835.

Notes: Baral *et al.* (1999) assigned this fungus to *Tatraea*, a genus in the Leotiaceae. We certainly notice the similarities between *C. peckiana* and the type species of *Tatraea* but would like to wait for more evidence to support this placement.

Dicephalospora rufocornea (Berk. & Broome) Spooner, Biblioth. Mycol. 116: 272, 1987.

Specimens examined: on twigs, Dingan, Hainan, IX 1934, S.Q Deng (4306), HMAS 07204; on bark, Xishan, Kunming, Yunnan, 9 VIII 1938, C.C. Cheo (83), HMAS 17063; *ibid*., 28 VIII 1938, S.Z. Zhao, HMAS 17064; *ibid*., 9 VIII 1938, F.L. Tai (86), HMAS 17067; on twigs, Xishan, Kunming, Yunnan, C.C. Cheo (34), HMAS 17068; *ibid*., 15 VII 1938, C.C. Cheo (39), HMAS 17069; *ibid*. 16 VII 1938, C.C. Cheo (50, 46), HMAS 17070, 17074; *ibid*., 18 VII 1938, C.C. Cheo (55), HMAS 17072; *ibid*., 9 VIII 1938, C.C. Cheo (81), HMAS 17073; on rotten wood, Xishan, Kunming, Yunnan, 14 VII 1938, C.C. Cheo (26), HMAS 17075; *ibid*., 27 VII 1941, C.C. Cheo (196), HMAS 17080; *ibid*., 22 VII 1942, W.F. Chiu (202), HMAS 17081; on small twigs, Wenshan, Yunnan, 17 VIII 1938, Q.H. Wang (97), HMAS 17082; on twigs, Xishan, Kunming, Yunnan, 28 VIII 1938, S.Z. Zhao (123), HMAS 17146; on fallen twig of broad-leaf forest, Huangshan, Anhui, 24 VIII 1957, S.C. Teng, (5052), HMAS 20312; on twigs, Huangshan, Anhui, 30 VIII 1957, S.C. Teng (5158), HMAS 20313; on fallen twigs, Tianmushan, Zhejiang, 9 IX 1957, S.C. Teng (5417), HMAS 20314; on rotten wood, Daji, Nanjing, Fujian, 11 VI 1958, S.C. Teng (5775), HMAS 24099; *ibid*., Diaoluoshan, Hainan, alt. 350 m, 26 IX 1958, Q.Y. Zheng (184), HMAS 26780; *ibid*., Nankengdaling, Nanjing, Fujian, 13 VI 1958, S.C. Teng (5840), HMAS 26792; on rotten twigs, Daqingshan, Longjin, Guangxi, 9 IX 1958, G.Z. Jiang (423), HMAS 26793; *ibid*., Qianlingshan, Guiyang, Guizhou, alt. 1400 m, 13 VIII 1958, Q.Z. Wang (94), HMAS 26794; *ibid*., Ceheng, Guizhou, alt. 800 m, 14 X 1958, Q.Z. Wang (549), HMAS 27120; on rotten wood, Nankengdaji, Nanjing, Fujian, 14 VI 1958, S.C. Teng (5880), HMAS 27121; on rotten twigs, Guanqian, Pucheng, Fujian, alt. 500 m, 28 VIII 1960, Q.Z. Wang & W.L. Yuan & G. He (762), HMAS 28770; *ibid*., Xipo, Baoting, Hainan, 31 VII 1960, J.H. Yu & R. Liu (1885), HMAS 29387; on twigs, Tianshidong, Qingchengshan, Sichuan, alt.1000 m, 15 VIII 1960, C.M. Wang & Y.X. Han (568), HMAS 30481; *ibid*., 16 VIII 1960, C.M. Wang & Y.X. Han & Q.M. Ma (586), HMAS 31244; *ibid*., Dashahe Nature Reserve, Daozhen, Guizhou, 20 VII 1988, Y. Li & Y.C. Zong & J.Z. Ying (500), HMAS 57797; *ibid*., 19 VII 1988, Y. Li & Y.C. Zong & J.Z. Ying (461), HMAS 58264; *ibid*., Yunnan, VIII 1992, S.X. Sun (259h), HMAS 61347.

Notes: This is a very common species in China. Most of the collections filed under *Helotium serotinum* (Pers.) Fr. in HMAS turned out to be *Dicephalospora rufocornea.*

Lanzia huangshanica W.Y. Zhuang & Korf forma ***aurantiaca*** W.Y. Zhuang, Mycosystema 7: 14, 1995.

Specimen examined: on leaf veins, Yanfang, Liuba, Shaanxi, alt. 950 m, 21 IX 1991, W.Y. Zhuang (850), HMAS 61874.

Lanzia serotina (Pers.: Fr.) Korf & W.Y. Zhuang, Mycotaxon 22: 506, 1985.

Specimen examined: on twigs, Haopingsi, Taibaishan, Shaanxi, alt. 1200 m, 14 V 1963, Q.M. Ma & Y.C. Zong (2230), HMAS 33625.

Notes: The stipe base of this collection seems not dark.

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TWO NEW DERMATEACEOUS GENERA WITH LANCEOLATE PARAPHYSES

AIN RAITVIIR

Institute of Zoology and Botany
Riia Street 181, EE-51014 Tartu, Estonia
e-mail: ain@zbi.ee

ABSTRACT: The taxonomic position of two species currently assigned to the Hyaloscyphaceae, *Dasyscyphus involucratus* and *Trichopezizella myricae* is reassessed, two new Dermateaceous genera *Involucroscypha* and *Obscurodiscus* are erected to accommodate them and the corresponding new combinations *Involucroscypha involucrata* and *Obscurodiscus myricae* are proposed.

Key words: taxonomy, Hyaloscyphaceae, Dermateaceae, new genera.

INTRODUCTION

There are two very rare and curious, dark, hairy Helotiales with lanceolate paraphyses, *Dasyscyphus involucratus* B. Erikss. and *Trichopezizella myricae* (P. Karst.) K. & L. Holm, currently assigned to the Hyaloscyphaceae which, however, do not fit the concept of genera they are placed in and the family as whole, too. Recently the author had an opportunity to study representative material of both species. In the result of this study two new genera of the Dermateaceae are proposed to accommodate those species.

MATERIAL AND METHODS.

The freshly collected living material was mounted in tap water, the dry herbarium material was resoaked in 3% aqueous solution of KOH. The Meltzer's reagent (MLZ), Congo Red (CR) and Cotton Blue (CB) were used for histochemical reactions. The mounts were examined by a Nikon Labophot-2 microscope equipped with a drawing tube. The size of microscopical structures was measured in 3% KOH using a 100x oil immersion objective lens if not stated otherwise.

TAXONOMY

Involucroscypha Raitv., genus novum.

Apothecia superficilia, breviter stipitata, minuta, primo obovoidea, cupulata, opaco nigra, extus furfuracea. Excipulum ectale ex cellulis globosis tenuiparietalis fuscis compositur, ad margine cum processibus fuscis tenuiparietalibus constrictoseptatis. Medulla ex cellulis globosis crassiter hyalinotunicatis amyloideis. Pili clavati, tenuiter vel subcrassiter brunneotunicati, verrucis hyalinis crustiforme confluentibus obtectis. Asci clavati, octospori, poro iodo caerulescentia praediti. Sporae hyalinae, aseptatae. Paraphyses lanceolatae, ascos longe superantes.

Typus generis: *Dasyscyphus involucratus* B. Erikss., Acta Univ. Ups. Symb. Bot. Ups. 19 (4): 16, 1970.

Apothecia superficial, shortly stipitate, often involucrate, a new apothecium proliferating from the centre of the old apothecium shell which persists as an involucrum, externally hairy and medium brown when fresh, dark brown when dry, with whitish to greyish hymenium. Ectal excipulum composed of textura globulosa, cells with thin, pale, yellowish walls. Externally the excipulum is densely covered with fascicles of adpressed brown hairs. Hairs clavate, arising from a wide basal cells at the flanks, narrowly rooting at the margin, with brown to dark brown slightly thickened walls, externally covered with a hyaline, strongly refracting, warty crust. Medulla composed of textura globulosa, cells hyaline, thick-walled, dextrinoid in MLZ. Asci cylindrical-clavate, with a short distinct stipe, 8-spored, apical pore blue in MLZ. Spores biseriate or obliquely uniseriate, hyaline, aseptate. Paraphyses lanceolatae, exceeding the asci.

Etymology: referring to the peculiar growth habit of the apothecia.

A single known species.

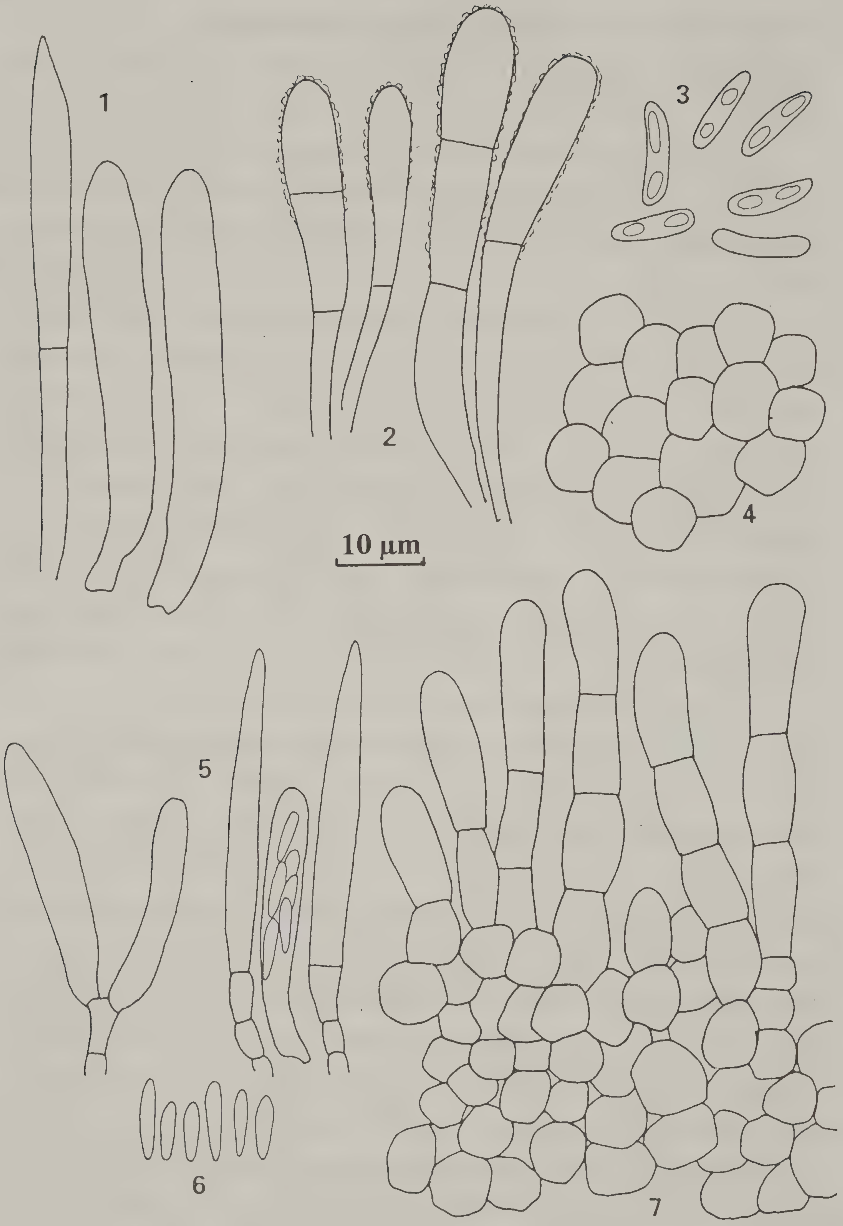
Involucroscypha involucrata (B. Erikss.) Raitv. comb. nov.
Basionymum: *Dasyscyphus involucratus* B. Erikss., Acta Univ. Ups. Symb. Bot. Ups. 19 (4): 16, 1970.
Figs. 1-4.

Apothecia superficial, shortly stipitate, 0.3-0.6 mm diam., often involucrate, a new apothecium proliferating from the centre of the old apothecium shell, externally hairy and medium brown when fresh, dark brown when dry, with whitish to greyish hymenium. Ectal excipulum composed of textura globulosa, cells 5-8 µm diam., with thin, pale, yellowish walls. Externally the excipulum is densely covered with fascicles of adpressed brown hairs. Medulla composed of textura globulosa, cells hyaline, thick-walled, dextrinoid in MLZ, 5-8 µm diam. Hairs clavate, arising from a wide basal cells at the flanks, narrowly rooting at the margin, 35-60 x 4-6 µm, apically swollen up to 8 µm, with brown to dark brown slightly thickened walls, externally covered with a hyaline, strongly refracting, warty crust. Asci arising from croziers, cylindrical-clavate, with a short distinct stipe, 8-spored, 40-55 x 5-7 µm, apical pore blue in MLZ. Spores biseriate or obliquely uniseriate, ellipsoid-fusoid, often slightly clavate and inequilateral to bemt,hyaline, aseptate, with 2 big polar lipid globules, 7-12 x 2-3 µm. Paraphyses lanceolatae, often 1-septate, without inclusions, 55-70 x 3-4 µm, exceeding the asci by up to 15 µm.

On dead stems of Ericaceae.

Specimens examined: Austria, Kärtnen: Koralpe,Pomseben,oberhalb des Wassenfalls, bei 1650 m, on dead stems of *Vaccinium vitis-idaea*, 5. VIII 1975, P. Remler (**GZU**, s.n.) Finland, Edela-Häme, Lammi Biological Station, on dead stems of *Calluna vulgaris*, 12. IX 2001, K. Leenurm (**TAA** 165831

This species with a curious habit and structure was described as a *Dasyscyphus* by Eriksson (1970) and treated under the same name by Remler (1979), too. But, in spite of its lanceolate paraphyses and rough “hairs”, it is not a *Lachnum* (=*Dasyscyphus*) and does not belong to the Hyaloscyphaceae at all. Its ectal excipulum, hidden under dense cover of adpressed hairs, is composed of textura globulosa and the hairs are different from typical hairs of the Hyaloscyphaceae. Its asci are different from asci found in the Hyaloscyphaceae but resemble closely the asci of a Dermateaceous genus *Coronellaria* which has also lanceolate paraphyses. The dense hair cover and involucrate growth of apothecia distinguish it clearly from the latter genus. But the involucrate growth of new apothecia from the shells of old apothecia can be sometimes observed in some other members of the Dermateaceae. The author has seen it in *Tapesia livido-fusca* (Fr.) Rehm and in some species of *Mollisia*. A characteristic feature of *I. involucrata* is dextrinoid medulla,



Figs. 1-4. ***Involucroscypha involucrata*****.** 1. A paraphysis and two asci; 2. Marginal hairs. 3. Spores; 4. Detail of ectal excipulum. **Figs. 5-7.** ***Obscurodiscus myricae*****.** 5. Asci and paraphyses; 6. Spores; 7. Ectal excipulum and marginal hairs.

overlooked by the earlier authors. The thick-walled cells of medulla turn beautiful light reddish brown, sometimes with rose-coloured tint in MLZ.

Obscurodiscus Raitv., genus novum.

Apothecia superficilia, sessilia, minuta, primo obovoidea, subsphaeroidea vel urceolata, dein cupulata, opaco nigra, extus furfuracea. Excipulum ectale ex cellulis globosis tenuiparietalis fuscis compositur, ad margine cum processibus fuscis tenuiparietalibus constrictoseptatis. Asci clavati, octospori, poro iodo caerulescentia praediti. Sporae hyalinae, aseptatae. Paraphyses lanceolatae, ascos longe superantes.

Typus generis: *Godronia myricae* P. Karst., Hedwigia 23: 5, 1884.

Apothecia superficial, sessile, minute., at first obovoid, subspherical or urn-shaped, later deeply cupulate or cupulate, opaque black when fresh and dry, externally furfuraceous. Ectal excipulum composed of textura globulosa, cells with firm, dark smoky brown walls, turning at the margin into hair-like hyphal processes with constricted septa and dark smoky brown, thin to slightly thickened walls. Asci cylindrical-clavate, 8-spored, apical pore deeply blue in MLZ. Spores hyaline, aseptate. Paraphyses lanceolate, hyaline, without inclusions, exceeding the asci.

Etymology: referring to the dark colour of apothecia.

A single known species.

Obscurodiscus myricae (P. Karst.) Raitv. comb. nov.
Basionymum: *Godronia myricae* P. Karst., Hedwigia 23: 5, 1884.
Syn.: *Trichopezizella myricae* (P. Karst.) K. & L. Holm, Nord. J. Bot. 11: 678, 1991.
Figs. 5-7.

Apothecia superficial, sessile, 0.2-0.4 mm diam., at first obovoid, subspherical or urn-shaped, later deeply cupulate or cupulate, opaque black when fresh and dry, externally furfuraceous. Ectal excipulum composed of textura globulosa, cells with firm, dark smoky brown walls, 5-8 µm diam., turning at the margin into hair-like chains of cells, composed of 2-4 cells with constricted septa and dark smoky brown thin to slightly thickened walls, 15-50 x 4-7 µm. Asci arising from simple septa, cylindrical-clavate, 8-spored, 25-30 x 4-5 µm, apical pore deeply blue in MLZ. Spores hyaline, clavate-fusoid, aseptate, without inclusions, 6-8 x 1.5 µm. Paraphyses lanceolate, hyaline, without inclusions, 1-3-septate at the base, 40-50 x 3-3.5 µm, exceeding the asci by up to 20 µm.

On dead branches of *Myrica gale*.

Specimens examined: Finland, Waasa, Qvarken (Wallgrund), on dead branches of *Myrica gale*, 20. VII, 1859, P. Karsten 3891a (syntype in **H**, annot. S. Huhtinen). Sweden, Dalarna, Sundborn parish, between Lake Långtjärn and the road Karlsbyheden-Korsån, on dead branches of *Myrica gale*, 18. VII 1978, K. & L. Holm, Fungi Exsiccati Suecici no. 3475 (**UPS**).

This extremely rare species, originally described as a *Godronia* (Karsten, 1884), is surely not Hyaloscyphaceous and should be placed into the Dermateaceae as it has typical Mollisiaceous hymenium and its marginal hairs are similar to those of some *Pirrotaea* species. It differs, however, from *Pirrotaea* in lack of grana and lanceolate paraphyses. The Karsten's original material in H is mostly juvenile and rather scanty but Fungi Exsiccati Suecici no. 3475 presents rich fully mature material in excellent condition. It seems to be a midsummer species which should be looked for in *Myrica gale* stands.

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THE PLEUROTUS ERYNGII SPECIES-COMPLEX IN ISRAEL: DISTRIBUTION AND MORPHOLOGICAL DESCRIPTION OF A NEW TAXON

LEWINSOHN D.[1], WASSER S.P.[1], RESHETNIKOV S.V.[1], HADAR Y.[2] AND NEVO E.[1]

1. International Center for Cryptogamic Plants and Fungi, Institute of Evolution, University of Haifa, Mount Carmel, Haifa 31905, Israel
2. Department of Plant Pathology and Microbiology, Faculty of Agricultural, Food and Environmental Quality Sciences, The Hebrew University of Jerusalem, Rehovot 76100, Israel

Dalia Lewinsohn - E-mail: dlevin01@study.haifa.ac.il

ABSTRACT

Thirteen wild populations of the *Pleurotus eryngii* species-complex (Pleurotaceae, higher Basidiomycetes) were collected in various geographical regions during an extensive survey on the occurrence of this complex in Israel. We sampled populations from the Golan Heights in northern Israel extending to the south steppic area of Lahav, in the northern Negev. We defined the exact geographical distribution of this complex in Israel. Previous studies described *P. eryngii* var. *ferulae* in close association only with *Ferula communis*. In our present study we found one population of *P. eryngii* growing in close association with *Ferula tingitana* in the Sataf area (Judean Mountains, Israel). The taxonomic study of this peculiar collection belonging to *P. eryngii* species–complex and the collection from Sataf is described as a new variety ***P. eryngii* var. *tingitanus*.** A comparative morphological analysis and mating experiments were conducted and microscopic features are described. The mycelium growth rate of isolates that were associated with *Ferula communis* were higher after 7 and 12 days of incubation than of isolates that were associated with *Ferula tingitana*. The new variety, ***P. eryngii* var. *tingitanus*** is closely related to *P. eryngii* var. *ferulae*, but it differs from the latter in spore size, mycelial characteristics, habitus of basidomata, or associated host plant and ecology.

KEYWORDS: *Pleurotus eryngii* var. *tingitanus*, *Ferula communis*, *F. tingitana,* taxonomy, morphology.

INTRODUCTION

The genus *Pleurotus* (Jacq.: Fr.) P. Kumm. (Pleurotaceae, higher Basidiomycetes) covers a group of lignotrophic species growing as saprotrophs on deciduous trees and rarely on coniferous trees, or as weak parasites on the lower part of the stems and roots of some Apiaceae species (Hilber 1982, 1997; Singer, 1986; Watling and Gregory, 1989; Zervakis and Balis, 1996). All *Pleurotus* species are edible or medicinal. Six *Pleurotus* species: *P. ostreatus, P. pulmonarius, P. eryngii, P.cornucopiae, P.cornucopiae* var. *citrinopileatus, P. dryinus* and *P. calyptratus,* are used in traditional medicine for at least 35 disorders or diseases (Ying et el., 1987; Stamets, 1995; Royse, 1997; Chang, 1999 a,b; Gunde-Cimerman, 1999; Guzman, 2000). Over the last twenty-five years, great efforts have been made to cultivate some taxa of *Pleurotus* species on a commercial scale. *Pleurotus* species account for 15% of worldwide mushroom production (Chang, 1999 a,b). Over 1000 species epithets have been proposed in *Pleurotus*, including names transferred into and out of the genus over the past two centuries (Petersen and Hughes, 1993, 1997; Petersen 1995). Newly proposed names continue to appear. Singer (1986) reported about 40 *Pleurotus* species for the world mycobiota. Recently, Petersen and Hughes (1997), considered only 15 *Pleurotus* species, including some North American species. Hilber (1982, 1997), and Moser (1983) reported 11-13 species for Europe, including seven species for the Nordic countries (Käärik, 1992), five species for Great Britain (Watling and Gregory, 1989), ten species for the former Soviet Union (Michailovsky, 1974). Zervakis et al. (1998) recognized four species in Greece, and eight intersterity groups in Europe (Zervakis and Balis, 1996).

Considering that there is no modern complete revision on the genus *Pleurotus*, there is much taxonomic confusion on the state of several species. It is certainly necessary to revise several described species and also to propose new species by combining classic and modern methodologies. We agree with Bresinsky et al. (1977, 1987) who pointed out that the species concept should be based primarily on macroscopical and microscopical morphological signs, chemical characters, and on ecological observation.

Pleurotus eryngii (DC.:Fr.) Quél. species–complex parasitizes the stem and the roots of some Apiaceae and is especially distributed in the subtropical-temperate climate of the Mediterranean region (Italy, Spain, Greece, Cyprus, France, former Yugoslavia, Israel, Lebanon) and central Asia (Uzbekistan, Tadzikistan, Turkmenistan, and Iran). It is also known from central Europe: Hungary (Rimoczi, 1992), Austria (Krisai-Greilhuber and Vogelmayer, 1995), Germany (Hilber, 1982, 1997; Krieglsteiner, 1991), Netherlands (Boekhout, 1990), Czech and Slovak Republics (Dermek, 1973; Klán, 1990), Ukraine (Wasser, 1971), and North Africa (Malénçon and Bertault, 1975).

Pleurotus eryngii species–complex are known from the following hosts: *Eryngium campestre* L., *E. maritinum* L., *Ferula communis* L., *Cachrys ferulacea* (L.) Calestani, *Thapsia garganica* L., *T. villosa* var. *fuscus*, *Elaeoselinum asclepium* Bert., *Diplotaenia* spp., *Ferulago* spp., *Laserpitium siler* L., *L. latifolium* L., *Pimpinella* spp., *Opopanax chironium* Roch., *Prangos ferulacea* DC., *Peucedanum cervaria* (L.) Lapeyr, etc. The *P. eryngii* species–complex has been described by many authors (Malénçon and Bertault, 1975; Binyamini, 1975; Hilber, 1982, 1997; Moser, 1983; Singer, 1986; Canduso and Basso, 1995; Krisai-Greilhuber and Vogelmayer, 1995). The content of the *P. eryngii* species-complex is interpreted in different ways. This conclusion is confirmed by the observation that the *P. eryngii* species-complex continues to be designated by one species (*P. eryngii*) which contains from five varieties to five independent species [(*P. eryngii, P. ferulae* (Lanzi) Sacc., *P. nebrodensis* (Inzenga) Sacc., *P. fuscus* (Battarra) Bres., *P. caespitoso-terrester* (P. Henn.) Pil.)]. According to Malénçon and Bertault (1975) there are four different varieties of *P.eryngii* in Morocco and Algeria (var. *eryngii*, var. *fuscus*, var. *caespitoso-terrester,* and var. *ferulae*). Hilber (1982, 1997) distinguished in *P. eryngii* only var. *ferulae*. Moser (1983) considered all types as one species *P. eryngii*, while Candusso and Basso (1995), stated that two species are valid, *P. eryngii* and *P. nebrodensis* for the mycobiota of Italy. Venturella (1998) illustrated the typification of *P. nebrodensis* and Venturella et al., (2000) described new var. of *P. eryngii*, *P. eryngii* var. *elaeoselini* Venturella et al., for the mycobiota of Sicily. Zervakis and Venturella (1998) presented their results of the systematics of the *Pleurotus* taxa growing on Umbellifers.

Prior authors disagreement on the taxonomical status of *P. eryngii* species-complex has led us to initiate a study of this taxon, which is widely distributed in Israel. Determination of a variety must consider the morphological structures, anatomical features, and other very important aspects such as the ecology and biology of the associated substrates.

In Israel, most of the *P. eryngii* species–complex grow in close association with *Ferula*, where it fruits from November to March. *F. communis* is the most widespread species of the genus *Ferula* in Israel. It is circum-mediterranean, and considered a poisonous plant. The distribution of *Ferula communis* in Israel has been described by Danin (1982).

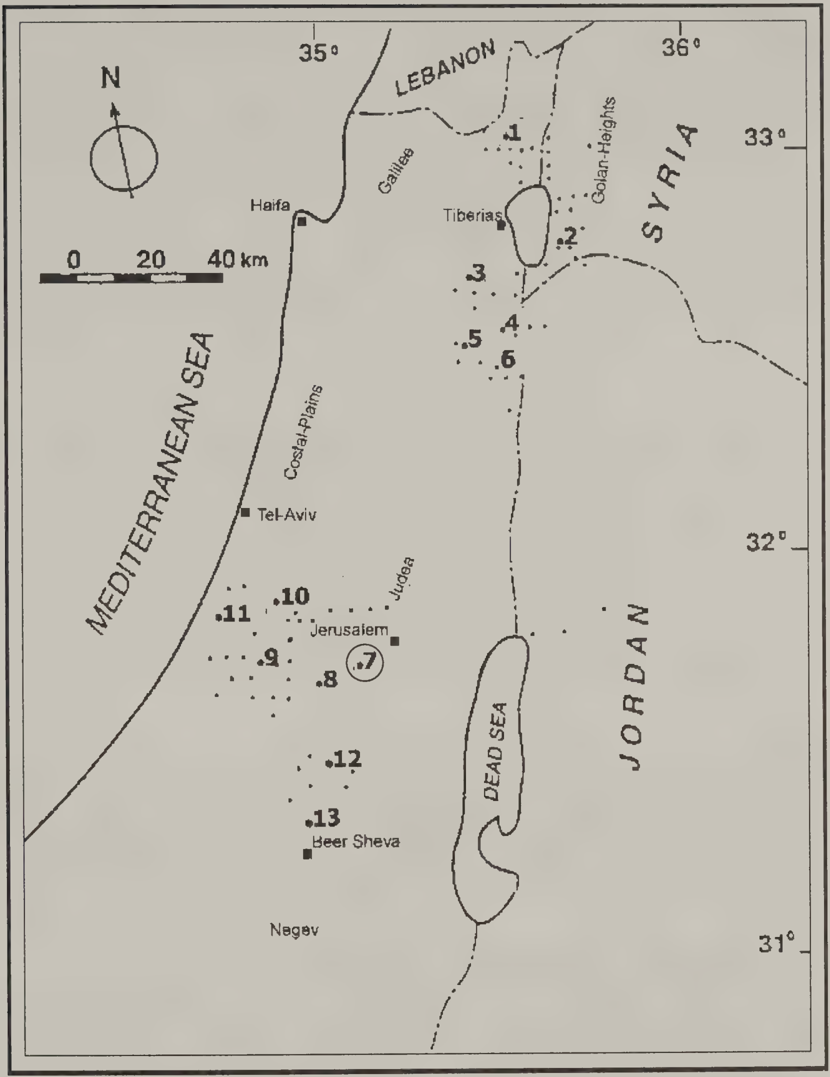
P. eryngii species–complex in Israel has not hitherto been critically studied. Particular data on *P. eryngii* appear in some publications devoted to the higher Basidiomycetes of Israel (Binyamini, 1975; Wasser, 1995). In this study we examined the ecogeographical variation and the genetic diversity in populations of the *P. eryngii* species-complex in Israel (Lewinsohn et al., 2000).

Herein, we studied the morphology and defined the geographical distribution of this complex in Israel, and we first reported that in the Judean Mountains *P. eryngii* species-complex is associated with *Ferula tingitana.* The taxonomic study and the collection from Sataf is described as a new variety.

MATERIALS AND METHODS

Biological material

During the winters of 1997-99, a total of 226 basidiomata of *Pleurotus eryngii* species-complex were collected (and 226 dikaryotic strains were isolated) from various geographical regions of Israel (Fig. 1, Table 1). Thirteen populations were delimited among them on the basis of RAPD-PCR analysis of DNA polymorphism (Lewinsohn et al., 2001). These collections have been deposited in the Herbarium of the International Center for Cryptogamic Plants and Fungi, Institute of Evolution, University of Haifa (HAI), Israel, and documented in the "Catalogue of Cultures" (Wasser et al., 2002).


35°
36°
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LEBANON
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JORDAN
MEDITERRANEAN SEA
DEAD SEA
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Golan-Heights
Haifa
Tiberias
Costal-Plains
Tel-Aviv
Judea
Jerusalem
Beer Sheva
Negev
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Fig.1: The distribution of *Ferula communis* and *F. tingitana* in Israel. [Marked with small dots on map). Numbers indicate localities where populations of *P. eryngii* species-complex were sampled (Table 1)].

Note: Population no. 7 grows in close association with *Ferula tingitana*. All other populations grow in close association with *F. communis*.

Table 1. Origin of the 13 populations of *Pleurotus eryngii* species-complex.

Population no. on map	Host/Substrate	Location	Total number of isolates
1	*Ferula communis*	Dishon	6
2	*Ferula communis*	Golan	21
3	*Ferula communis*	Mt.Tabor	11
4	*Ferula communis*	Menahchamyiah	26
5	*Ferula communis*	Tel-Bet She'an	15
6	*Ferula communis*	Mt. Gilboa	14
7	***Ferula tingitana***	Sataf	11
8	*Ferula communis*	Har-Hatayasim	24
9	*Ferula communis*	Zorah	25
10	*Ferula communis*	Harel	12
11	*Ferula communis*	Gedera	16
12	*Ferula communis*	Amazia-Lachish	36
13	*Ferula communis*	Lahav-Devira	9
Total			226

Media

MEA (Malt extract agar) was prepared according to Gams et al. (1978). The pH of MEA was 6.5±0.4. The medium was autoclaved for 30 min. at 121 ° C, then cooled and poured into sterile test tubes or Petri dishes.

Strain isolation and maintenance of culture stocks

Small pieces (about 1 cm in diameter) of the collected basidiomata were removed using aseptic techniques and placed on Petri dishes containing MEA. The cultures were kept at room temperature and transferred several times until pure cultures were obtained. MEA slant tubes were inoculated from Petri dish colonies, incubated at 4 ° C, and transferred every 6 months for routine maintenance. Actively growing cultures were incubated at 27 ° C (Gams et al., 1978). A total of 226 cultures of *P. eryngii* complex were isolated and kept at 4 ° C for further tests.

Measurements of growth rate of fungal isolates

Four dikaryotic isolates obtained from Zorah (associated with *F. communis*) and four dikaryotic isolates obtained from Sataf (associated with *F. tingitana*) were inoculated from Petri dishes containing MEA in four replicates (Table 1, Fig.1). The cultures were incubated at 27°C for 10 days. Then, 7 mm disks were cut off with a sterile cork borer from the border of the mycelial colony. Each disk was placed into the center of a sterile Petri dish with Malt extract agar by using a sterile scalpel and incubated at 27° C, until the first strain colonized the entire Petri dish. The growth rate of the cultures were compared after 7 and 12 days of incubation.

Mating experiments

Freshly collected naturally growing basidiomata of *P. eryngii* were placed over a sterile Petri dish in a moist chamber at conditions of slowly decreasing humidity. Basidiospore prints obtained 12-24 hours later were kept in a refrigerator at 4°C. Basidiospore suspensions were prepared in sterile water (1-2 microbiological loops per 5 ml of water), and up to four serial dilutions 1:10 were developed. Basidiospore suspensions from each dilution of 0.5 ml were spread uniformly on MEA surface on a Petri dish. Inoculated dishes were incubated at 24° C in the dark.

One week after incubation, germlings were investigated under the stereomicroscope, and individual microcolonies were transferred by sterile needle into Petri dishes with fresh agar. Colonies obtained were microscopically investigated for clamp connection absence, and 12-14 of them, derived from a single basidomata, were used for determination of mating types in monosporous isolates.

Pairings were set up by placing mycelia plugs freshly cut from Petri dish colonies with a cork borer (5 mm diameter) about 15–20 mm apart on MEA Petri plates. After one week when the colonies had grown over the zone of contact, the mycelium was examined for the occurrence of clamp connections.

Microscopic features

In order to obtain spore-prints, pilei were placed (gills facing downwards) over white Whatman filter paper #1. The micromorphology, length and width of sixty basidiospores of specimens from each population were measured with the aid of the Olympus Bx100 microscope (magnification 100x).

RESULTS AND DISCUSSION

The geographical distribution of *Pleurotus eryngii* species-complex in relation to *Ferula* spp. and the association between *Pleurotus eryngii* and Apiaceae

Israel is located in an area where the monthly maximum and the total annual values of solar radiation are among the highest in the world, resulting in high annual temperatures and extensive aridity. It consists of three main climatic regions, Mediterranean, steppe, and desert climates (Atlas of Israel, 1970). Our previous study and publications (Lewinsohn et al., 2001) showed a high positive polymorphism correlation with the trend of drought in *P. eryngii* species–complex. We also found that Israeli populations are well adapted to the hot and dry climate and can tolerate extreme temperature conditions.

The geographical distribution and the ecological habitats of *Pleurotus eryngii* species–complex in Israel parallel the three main climatic regions: Mediterranean, steppe, and desert climates (Lewinsohn et al., 2000) and the distribution of *F. communis* in Israel (Fig.1). This includes the area of the lower Galilee, the Hula Valley and the slopes of the Golan Heights and Mt. Gilboa, and the southern coastal plain on the sandy stone hills (Gedera area) to the northern Negev (Lahav steppic area). In all these locations, *P. eryngii* was found in close association with *F. communis*, in areas heavily grazed by cattle. Only in one place near the water springs of Sataf (located in the Judean Mountains, population 7, Fig. 1), we found many individuals of *P. eryngii* growing in close association with *F. tingitana*. This is the first report in Israel that describes another Apiaceae host of the *P. eryngii.* In Israel *P. eryngii* has not been found in the northern coastal plain, western and upper Galilee, hence its distribution is assumed to be primarily in the Irano-Turanian and marginal Mediterranean phytogeographical regime (Fig.1; Atlas of Israel, 1970).

It is interesting how much this complex has a unique association with the higher plants of the Apiaceae species, especially in Israel where many other species in this family grows in the wild and the fungi have selected one species to be associated with, *Ferula communis.*

Such phenomena can raise evolutionary questions, and it could be a result of co-evolution between the host-plant and fungus. The presence of cattle positively selects for this plant, since it is poisonous and normally avoided by cattle.

The reason why we found only one place where *P. eryngii* associates with *Ferula tingitana* could be, that *F. tingitana* grows mainly in the Mediterranean climatic regions, on chalk slopes of mountains (Danin, 1982). Possibly the Mediterranean distribution of *F. tingitana* and the vertical rocky cliffs on which it grows do not provide appropriate region, soil, and habitat, for *P. eryngii.*

Growth rate

Comparing the growth rate of cultures obtained from Zorah with those of Sataf shows that: the Zorah isolates grew about 7 mm/day but after 7 days of incubation they reached up to a maximum 50x45 mm in diameter. The Sataf isolates grew about 4.5 mm/day and reached a maximum of 35x32 mm in diameter after 7 days with in the same conditions. After 12 days of incubation the growth rate of the Zorah isolates reached a maximum 80x78 mm in diameter while the Sataf isolates reached only 54x53 mm in diameter. So clearly the Sataf associations grow slower than those of Zorah.

Mating experiments

Tetrapolar heterothallism as system of sexual reproduction

Mating experiments within Zorah and Sataf stocks revealed all 4 mating types of haploid cultures obtained from the basidiospore print of each stock.

The mating reactions of Sataf homokaryons can be recognized macroscopically, as positive or negative, while sometimes “barrage” formation was observed. “Barrage” formation in *Pleurotus ostreatus* species is generally associated with the common presence of B factor (Eger, 1978). We classified mating groups according to this type of reaction. A positive mating was not followed by aerial dikaryotic mycelium formation thus, a careful microscopic examination was needed for clamp detection on hyphae at the contact zone.

Monokaryons of Zorah origin developed no “barrage”-type reaction on agar plates. The type of mating reaction can be detected only microscopically, since dikaryotic mycelium was not formed in abundance when compatible monokaryotic hyphae came into contact.

In order to investigate the level of biological differentiation of two stocks, four tester monokaryons from each stock were crossed in all possible combinations (Fig. 2). Nevertheless, microscopic examination aided determination of clamp formation in all matings types (Table 2).

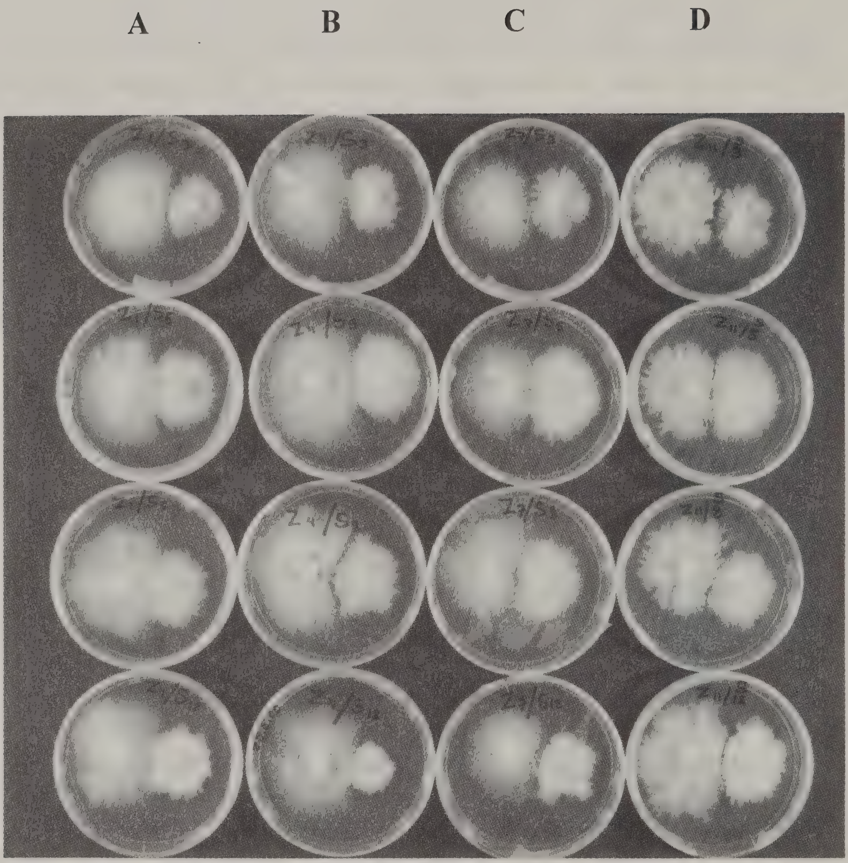

Fig. 2: Mycelial interaction in agar plates (85 mm diameter) at 27° C on MEA of Zorah (Z on the left side of the plate) and Sataf (S on the right side of the plate) haploid cultures.

(Note the slow growing cultures of Sataf compared to those of Zorah).

A. Z_1 / S_3, Z_1 / S_5, Z_1 / S_8, Z_1 / S_{12} **B.** Z_4 / S_3, Z_4 / S_5, Z_4 / S_8, Z_4 / S_{12}

C. Z_7 / S_3, Z_7 / S_5, Z_7 / S_8, Z_7 / S_{12} **D.** Z_{11} / S_3, Z_{11} / S_5, Z_{11} / S_8, Z_{11} / S_{12}

Table 2: Results of matings between Sataf (S) and Zorah (Z) stocks tester homokaryons.

Mating types and strain number	A_2B_1 Z_1	A_1B_1 Z_4	A_1B_2 Z_7	A_2B_2 Z_{11}
A_2B_2 S_3	+	+	+	+
A_1B_2 S_5	+	+	+	+
A_1B_1 S_8	+	+	+	+
A_2B_1 S_{12}	+	+	+	+

Compatible mating producing clamp connections are represented by a "+".

The results of crossing experiments indicated that no common incompatibility alleles existed between the Sataf and Zorah stocks. This means that at least the two stocks investigated do not belong to a common population, but they are still members of the same biological species.

Basidiospores measurements

Tukey-Kramer statistics test indicated that the Sataf basidiospores are significantly ($p<0.05$) larger [**(10) 12-15(15.8) x (3.8) 5-7.2 (7.9)** µm] (Fig. 3), than the rest of the 13 populations that were examined. Additionally, basidiospores from the Golan were smaller [**(7.6) 8.8-10.6(11) x (4.7) 5-6 (6.9)** µm] and from Har Hataysim (located only about 10 km apart from Sataf) they were significantly smaller [**(6.3) 7.5-9.6(10.6) x (3.9) 4.5-5.8 (6.7)** µm] than the other basidiospores from all other populations.

Morphological description

A study of morphological characteristics (basidiomata, microstructures, mycelial cultures) and ecology showed that the *P. eryngii* species-complex is represented in Israel by two well-distinguished taxa: *P. eryngii* var. *ferulae* and ***P. eryngii* var. *tingitanus* var. nov.** Below, the descriptions of a new variety for science is presented.

***Pleurotus eryngii* (DC.:Fr.) Quél. var. *tingitanus* Lewinsohn var. nov.** (Figs. 3, 4).

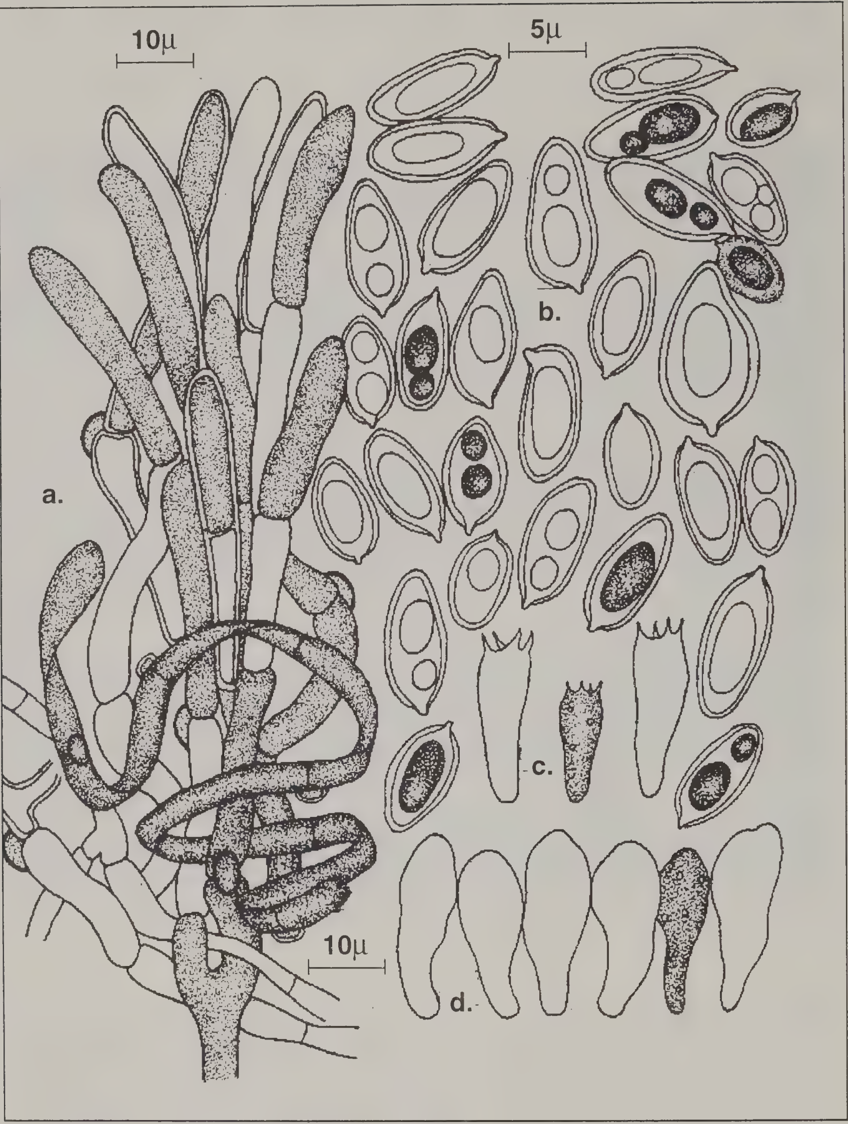
10µ
5µ
b.
a.
c.
10µ
d.

Fig 3: *Pleurotus eryngii* var. *tingitanus* (HAI, Typus).

a. elements of pileal cuticle	**c.** basidia
b. spores	**d.** cheilocystidia

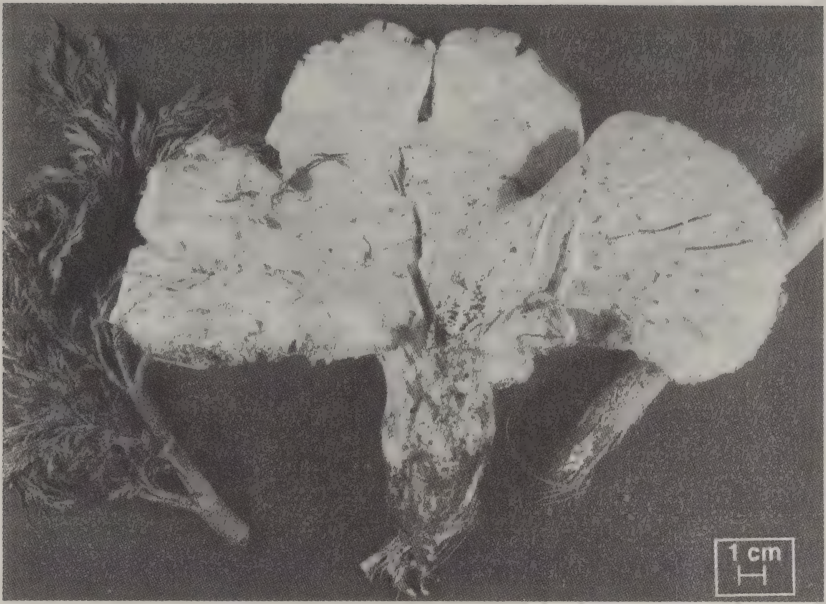

Fig. 4: Basidiomata of ***P. eryngii*** **var.** ***tingitanus*** (growing in close association with *Ferula tingitana*).

A tipo (*P. eryngii* var. *eryngii*) differ: Pileus 6.5-26 cm latus. Basidia tetrasterigmata 23-33x8-11 µm, clavate. Cheilocystidia 24-43x9-16 µm. Sporae 10-15.8x5.0-7.9 µm, cylidraceae, ellipsoideae, hyalinae.

Typus: Israel, Sataf, ad radices *Ferula tingitana* L., 02.02. 1999, leg. et det. D. Lewinsohn, in herbario INST. Evolution (HAI) conservatur, N-3399.

Etymology: *P. eryngii* var. *tingitanus*, named after the host that it was found to be associated with, *Ferula tingitana.*

Pileus: 6.5-26 cm in diameter, thick-fleshy, first hemispherical, later flat and fully expanded to concave, slightly centrally depressed, with inrolled and sometimes remaining down-turned margin, or lobed at the margin or splitting; surface in young specimens smooth, radially fibrillose, or with appressed squammules, especially to the margin, sometimes at the margin becoming areolate-cracked, uniformly colored, snuff brown buff, ochraceous brown, cream. Pileal cuticle consisting of ochraceous brown, cream, thin-walled, cylindrical, septate hyphae 3-16 µm in diameter with clamp connections.

Lamellae: decurrent, often slightly anastomosing near stipe, rather thin, up to 10mm wide, cream when young, cream-clay, later pale pinkish cream with somewhat brownish edge. **Lamellar trama:** monomitic, generative hyphae densely interwoven, 3-13 μm in diameter, thin-walled, with clamp connections. **Basidia:** 4-sterigmate, 23-33x8-11 μm, clavate. **Cheilocystidia:** 24-43x9-16 μm, irregularly clavate, irregularly distributed (some parts of the gill edges even without cheilocystidia). Spore print white (fresh), later slightly ochraceous. **Basidiospores:** (10) 12-15 (15.8)x(3.8) 5-7.2 (7.9) μm, hyaline, oblong to cylindrical. **Stipe:** 1.3-12x1.5-3.8 cm subcentral to eccentric, rarely central, cylindrical, tapered from apex to base, whitish-cream, ochraceous, smooth or subpubescent with squamules. Flesh solid, elastic, whitish, becoming yellow; mild taste; anise-like odor. **Mycelial cultures:** pink to yellow-orange pigments especially on monokaryotic mycelial cultures. Mycelial colonies mostly presenting a flat and loose aerial mycelium. Growth rate of mycelial cultures about 4.5 mm/day.

Type: Israel, Sataf springs, in the Judean Mountains, associated with *Ferula tingitana* 02.02.1999, coll. D. Lewinsohn.

Note: This new variety is morphologically related to *P. eryngii* var. *ferulae*, but differs in spore size, mycelial characteristics, and growth rate of the mycelia, habitus of basidiomata, associated host plant, and ecology. The data about *P. eryngii* var. *ferulae* elucidated on the basis of previously reported literature (Hilber, 1982, 1997; Boekhout, 1990; Krisai-Greilhuber and Vogelmayer, 1995).

CONCLUSION

In this study we define the geographical distribution of the *P. eryngii* species-complex in Israel. We examined the morphological and cultural characteristics and mating system of a *P. eryngii* population, which enabled us to describe a new variety of *P. eryngii* complex in Israel. This is the first report on an association between *P. eryngii* and *Ferula tingitana*. The morphological differences enabled us to distinguish between the two varieties of *P. eryngii* for the mycobiota of Israel; *P. eryngii* var. *ferulae* and ***P. eryngii* var. *tingitanus*.**

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PLEUROTUS ERYNGII VAR. THAPSIAE VAR. NOV. FROM SICILY

G. VENTURELLA[1], G. ZERVAKIS[2] & A. SAITTA[1]

[1]Dipartimento di Scienze Botaniche, University of Palermo, Via Archirafi 38, I-90123 Palermo, Italy. gvent@unipa.it
[2]National Agricultural Research Foundation, Institute of Kalamata, Lakonikis 85, 24100 Kalamata, Greece. zervakis@kal.forthnet.gr

ABSTRACT

Field investigations in the Sicilian territory allowed the study of *Pleurotus eryngii* basidiomata growing in association with *Thapsia garganica*. The evaluation of morphological, ecological, distribution, and isozyme and PCR-RAPD data together with a revision of Bresadola's herbarium specimens kept in the Herbarium Botanische Staatssammlung (M) led to the description of a new variety, *Pleurotus eryngii* var. *thapsiae* var. nov.

KEY WORDS: fungal taxonomy, ecology, Mediterranean area, *Pleurotus eryngii*, Umbellifers, edible mushrooms, Apiaceae.

INTRODUCTION

Recent mycofloristical, geographical and ecological studies together with RAPD-PCR and isozyme analysis were carried out to elucidate the perplexed relationships among the different taxa growing in association with Umbellifers and forming part of the so-called "*Pleurotus eryngii* species-complex" (Zervakis & Balis, 1996; Zervakis & Venturella, 1998; Venturella, 2000; Venturella & al., 2000; Zervakis et al., in press).

According to these investigations the infrastructure of the *P. eryngii* species-complex in the Mediterranean area is composed of the following host-specific taxa: *Pleurotus eryngii* (DC. : Fr.) Quél. var. *eryngii* growing on root residues of *Eryngium campestre* L., *P. eryngii* var. *ferulae* Lanzi on *Ferula communis* L. subsp. *communis*, *P. nebrodensis* (Inzenga) Quél. on *Cachrys ferulacea* (L.) Calestani, and *P. eryngii* var. *elaeoselini* Venturella et al. on *Elaeoselinum asclepium* (L.) Bertol. subsp. *asclepium*.

In addition, an interesting and misappreciated *P. eryngii* population growing on *Thapsia garganica* L. in Sicily, which was considered to belong to *P. eryngii* var. *eryngii* was studied in detail. A re-evaluation of morphological, ecological, distribution and other taxonomic data permitted its proposal as a new variety, *Pleurotus eryngii* var. *thapsiae*.

MATERIALS AND METHODS

Periodical field observations and collection of *Pleurotus* basidiomata growing on *Thapsia garganica* L. have been carried out in Sicily from 1995 until the present day. Morphological, distributional and ecological characters were also evaluated in conjunction with the examination of *Pleurotus* specimens kept in the Herbarium Botanische Staatsammlung (M).

Microscopical observations were made in an aqueous solution with the aid of a micrometer (x1000). Spores were taken directly from the spore prints which were obtained on glass slides. For examination of herbarium material a piece of lamellae was removed from each sample and rehydrated in L4 or KOH 5%. Mycelium cultures were maintained on PDA (Bacto potato dextrose agar, Difco), and are stored in the Culture Collections at the authors' Institutions.

The type specimen is kept in the Herbarium Mediterraneum (PAL).

DESCRIPTION

Pleurotus eryngii var. *thapsiae* Venturella, Zervakis et Saitta, var. nov. (Fig. 1).
Etym.: from the name of the genus of the associated plant (i. e. *Thapsia*).
SYN.: *Pleurotus fuscus* (Batt.) Bres. var. *ferulae* Lanzi s.l. Bres.; *Pleurotus fuscus* (Batt.) Bres. var. *nebrodensis* Bres. s.l. Bres.

Basidiomata valida atque robusta, una, haud saepe luxuriosa. *Pileus* 2-10 cm, convexus dein explanatus, postremo depressus, perraro reflexo-infundibuliformis. Pilei pellis haud facile separabilis, velutina atque opaca, cerea cum pigmentis, et laxatis squamis, fusca, margine tenui acutaque, maxime involuta, subtilibus venis ornata, in senectute irregulariter plana et interdum lobata. *Lamellae*, cineraceo colore, spissae, arcuatae, cum lamellulis, decurrentes, anastomosantes in supera parte stipitis, plus minusve evidentes. *Stipes* 4-7,5 x 1,2-2,8 (3,6) cm, solidus, plenus, irregulariter cylindricus, ad basim attenuatus vel subradicatus, medianus vel excentricus, albus paene pullus colore, inde levis et glaber. *Caro* compacta, fibrosa, elastica, alba; odor saporque debiles, vulgares. *Sporae* 10-14 x 5-7 μm (Q = 1,9-2,1), hyalinae (in KOH etiamque in Melzer), leves, cylindraceae vel irregulariter ellipsoideae, pluriguttulatae, apiculo manifesto praeditae. *Basidia* 32-54 x 6-9 μm, tetraspora, clavata, cum sterigmatibus 4-6 μm longis. *Cheilocystidia* 8-12 x 40-65 μm, basidiis similia, superne attenuata, interdum acute mucronata. *Pileicutis* ex hyphis cylindricis radialibus, 5-12 μm latis, constituta. Fibulae praesentes.

Locus: graegaria in herbidis locis, cum Thapsiae garganicae consociata.

Typus — Madonie Mts, locality Piano Zucchi (Palermo, Sicily), 37° 54′ 01″ N 13° 59′ 40″ E, arid pastures with *Thapsia garganica*, on calcareous soil, 1000 m, 11 May 1995, leg. G. Venturella (holotypus in PAL).

Basidiomata sturdy and fleshy, single, seldom caespitose. *Pileus* 2-10 cm, convex then flat, finally depressed, seldom reflexed or funnel-shaped. Cuticle not easily detachable, velvety, pruinose with pigments, opaque, with scattered squammules, dark brown, then smooth, bright and greasy-like appearance in ripe basidiomata. Margin thin, acute, deeply involute and adorned by thin ribs, then flat, irregular, and sometimes also lobate. *Lamellae* greyish white, thick, arcuate, mixed by lamellulae, deeply decurrent with anastomoses, more or less evident, at the point of attachment with stipe. Lamellae margin entire, subconcolorous to the pileus. *Stipe* 3-5 x 1-3 cm, sturdy, filled and firm, irregularly cylindrical, attenuate at the base, sometimes radicating, central and sometimes eccentric, white-brownish, then smooth and glabrous. *Flesh* firm and compact, fibrous, elastic, white, with a fungus-like smell and taste. *Spores* 10-14 x 5-7 μm (Q = 1,9-2,1), cylindrical to irregularly ellipsoid, smooth, hyaline, guttulate with pronounced apiculus. *Basidia*, club-shaped, 4-sterigmata, 32-54 x 6-9 μm, sterigmata 4-6 μm. *Cheilocystidia*, 8-12 x 40-65 μm, rare, club-shaped, with irregular apex, acute to subglobose, sometimes showing a thin acute beak. *Epicutis* with cylindrical hyphae, 5-12 μm wide, closely appressed. Texture cutis-like. Clamp connections abundant in all parts of the basidioma. Basidiospores, basidia and trama (with occasional presence of oleiferous hyphae) hyaline in aqueous KOH and Melzer's reagent.

Culture characteristics on PDA: pigments absent, reverse colour unchanged, dikaryotic colonies mostly presenting a loose submerged and suppressed aerial mycelium, more or less zonate and radial, growth margin even and regular, colour white to cream; thin-walled hyphae, hyaline in aqueous KOH and Melzer's reagent, with abundant clamp-connections; occasional production of microdroplets, singly on short secretory sterigmata on aerial hyphae (nematode trapping devices); optimal fungal growth 25°C (2.2 mm day^{-1}).

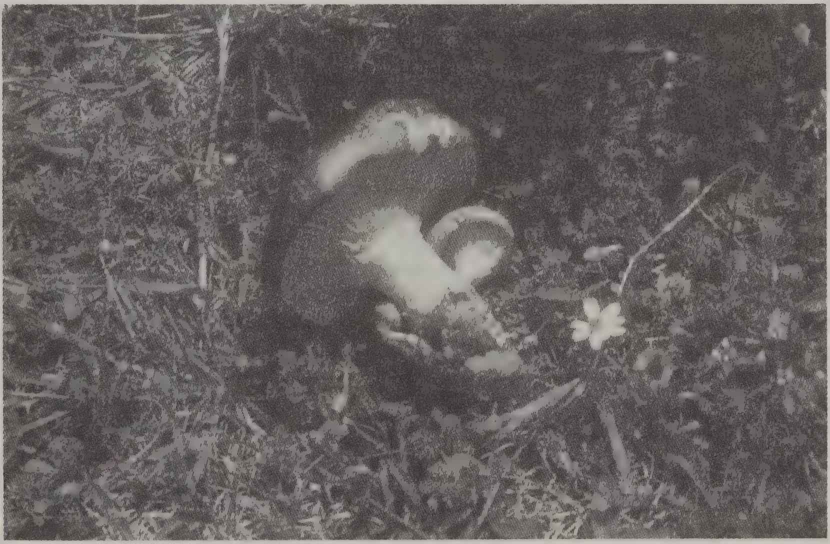

Fig. 1. Basidioma of *P. eryngii* var. *thapsiae*.

Specimens examined: MÜNCHEN: Fiemme alla Bellamonte, ad radice, *Laserpitii latifoliae*, in pratis, IX. 1925, *Pleurotus fuscus* (Batt.) Bres. var. *ferulae* Lanzi (M). PALERMO (SICILY): Piano Zucchi, on root residues of *Thapsia garganica*, calcareous soil, 1100 m, 27 Apr 1995, 11 May 1995, 06 May 1996, 29 Apr 1997, 13 May 1997, 24 May 1998, 16 May 1999, 25 Apr 2000, 08 May 2000, leg. G. Venturella (PAL); Piano della Madonna, on root residues of *Thapsia garganica*, calcareous soil, 1500 m, 12 May 2001, leg. A. Saitta (PAL).

DISCUSSION

In the Mediterranean area the *Pleurotus eryngii* species-complex includes many host-associated taxa. Particularly in Sicily, the *Pleurotus* populations associated with Umbellifers show a high degree of diversity (Zervakis & Venturella, 2002).

Bresadola (1932) considered *Pleurotus nebrodensis* (sub *Agaricus eryngii* var. *nebrodensis*) as a synonym of *P. fuscus* (Batt.) Bres. var. *ferulae* Lanzi. Within *P. fuscus* var. *ferulae* s. l., two ecotypes were distinguished by Bresadola: *P. fuscus* var. *ferulae* growing on *Laserpitium latifolium* (the so-named "fungo d'Ampezzo" or "fungo della Bellamonte") in central Europe (including northern Italy) and *P. fuscus* var. *nebrodensis* on *Ferula communis* ssp. *communis*, *Elaeoselinum asclepium* ssp. *asclepium*, *Opopanax chironium*, etc., in Sicily on the Madonie Mts.

Mattirolo (1938) realized that "probably the *P. fuscus* varieties reported by Bresadola could be considered as local varieties of *P. eryngii* which are associated with different Umbellifers and habitats".

Mattirolo's interpretation is indeed in accordance with the individual population structure within the *Pleurotus eryngii* species-complex in Sicily, where basidiomata growing on various host-plants (other than *Eryngium* and *Ferula* spp.) possess intermediate characters between *P. eryngii* var. *eryngii* and *P. eryngii* var. *ferulae* (Zervakis & Venturella, 1998). Besides, recent investigations demonstrated that *Pleurotus nebrodensis* is strictly associated with *Cachrys ferulacea*, whereas *Elaeoselinum ascelpium* ssp. *asclepium* is the host-plant of *P. eryngii* var. *elaeoselini* (Venturella, 2000; Venturella et al., 2000). The same studies could not reconfirm the occurrence of *P. nebrodensis* on *Opopanax chironium*, while they provided the evidence that *Ferula communis* is the only plant species associated with *P. eryngii* var. *ferulae*. In addition, RAPD-PCR and isozyme analysis (Zervakis & Venturella, 1998; Zervakis et al., in press) confirmed a clear separation of *P. nebrodensis* from the "*P. eryngii* species-complex".

Furthermore, several morphological characteristics and particularly the dark colour of the pileus of *P. fuscus* var. *ferulae* (Bresadola, 1932) excluded any resemblance to the current notion of *P. nebrodensis* and *P. eryngii* var. *elaeoselini* which are both characterized by white basidiomata (Venturella, 2000; Venturella et al., 2000). Hence, the description of *P. fuscus* var. *ferulae* should correspond to another taxon.

Indeed, the macroscopic and microscopic features of *P. fuscus* var. *ferulae* (*sensu* Bresadola) are very similar to those of *Pleurotus* basidiomata growing on *Thapsia garganica* Moreover, the observations on the *Pleurotus fuscus* var. *ferulae* herbarium specimens, collected in 1925 by Bresadola on *Laserpitium* *latifolium*, and kept in the Herbarium Botanische Staatsammlung (M), sub *P. eryngii* var. *nebrodensis* (a Hilber's revised attached label), show that the spore size is smaller than in *P. nebrodensis* and corresponds to the spore range of taxa included in the *P. eryngii* species-complex. It also evidences that *Pleurotus* strains growing on *Laserpitium* spp. in central and northern Italy present identical morphological characteristics to those of *Pleurotus* populations associated with *T. garganica* in Sicily. Hence, these two allopatric populations growing on different host-plants belong to the same taxon, *P. eryngii* var. *thapsiae*.

Pleurotus eryngii var. *thapsiae* is a spring mushroom, locally named "firrazzolu" with reference to the vernacular name used for *Thapsia garganica* in the Madonie Mts. (north Sicily). *P. eryngii* var. *thapsiae* was collected on calcareous soils, in arid pastures with *Thapsia garganica* and *Eryngium campestre*, and at elevations ranging from 1000 to 1500 m. The appearance of the basidiomata is restricted, from the end of March until May. The basidiospores in *P. eryngii* var. *thapsiae* are irregularly ellipsoid to cylindrical (10-14 x 5-7 µm, Q = 1.9-2.1) (Fig. 2).

This variety possesses also basidiole-like cheilocystidia with an attenuate apex at the top, and sometimes with an acute beak, showing a close resemblance to *P. eryngii* var. *elaeoselini* microscopic features. The macroscopic and microscopic features of this new taxon correspond to those described for *P. fuscus* var. *ferulae* s. Bresadola (1932), as confirmed by the observations made on the specimens kept in M.

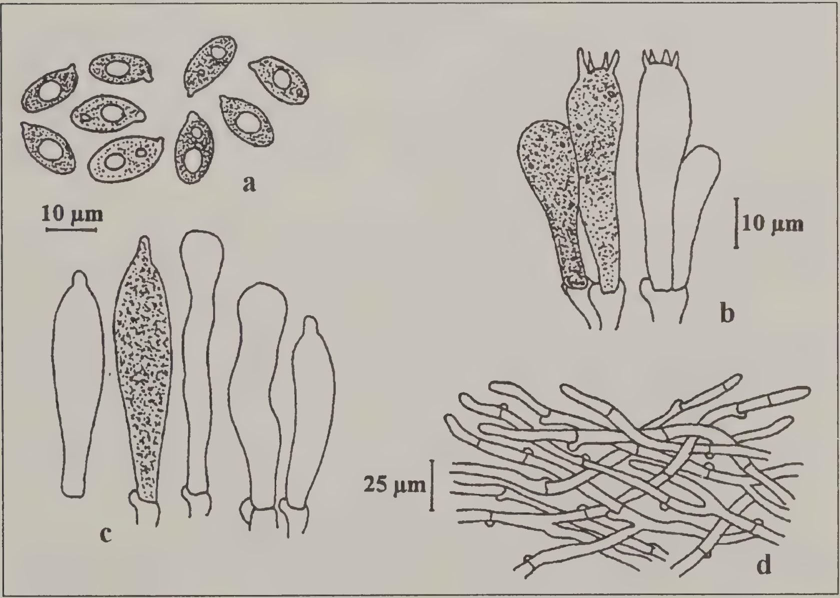

Fig. 2. *Pleurotus eryngii* var. *thapsiae* – **a.** spores, **b.** basidia, **c.** cheilocystidia, **d.** epicutis.

P. eryngii var. *thapsiae* differs from *P. eryngii* var. *eryngii* and from *P. eryngii* var. *ferulae* in producing significantly smaller and darker basidiomata. In addition, the *P. eryngii* var. *eryngii* basidiomata are produced singly or in clusters from early autumn to winter, while basidiomata of *P. eryngii* var. *thapsiae* appear mostly singly and in spring. Moreover, *P. eryngii* var. *eryngii* is quite common and occurs from sea level to 1500 m while *P. eryngii* var. *thapsiae* is infrequent and restricted to the mountainous zone. *P. eryngii* var. *thapsiae* is also ecologically separated from *P. eryngii* var. *ferulae*; the latter grows on *Ferula communis* ssp. *communis* root residues in garrigues, waste lands and arid pastures, and it is widespread throughout Sicily, mainly on calcareous soils from sea level to 1000 m. Analysis based on isozyme and PCR-RAPD data (Zervakis & Venturella 1998; Zervakis et al., in press) further confirmed the distinct taxonomic position at the varietal level of *Pleurotus* populations growing in association with *Thapsia garganica* Therefore, the interpretation of all available data support the hereby proposed description of a new *Pleurotus* taxon from Sicily, *P. eryngii* var. *thapsiae*.

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MATERIALS FOR A HYPOGEOUS MYCOFLORA OF THE GREAT BASIN AND ADJACENT CORDILLERAS OF THE WESTERN UNITED STATES. VII: A NEW TRUFFLE-LIKE PEZIZA (ASCOMYCOTA, PEZIZALES)

Robert Fogel
University of Michigan Herbarium, North University Building,
Ann Arbor, Michigan 48109-1057

Jack States
Department of Botany, University of Wyoming, Laramie, Wyoming
82071[1]

ABSTRACT

A new truffle-like species of *Peziza*, *P. quercicola,* associated with *Quercus gambelii* and *Q. turbinella* from southwestern Utah, United States, is described and illustrated.

Key Words: hypogeous fungi, sequestrate, biogeography.

This is the seventh in a series containing materials for a hypogeous mycoflora of the Great Basin and adjacent Cordilleras (Fogel 1994; Fogel and Pacioni, 1989). The region has received little attention from mycologists despite its potential for studies of fungal biogeography, evolution, and coevolution. The Great Basin, as defined by Cronquist et al. (1972), occupies an area of 714,854 square km. The vegetation in the region contains many suitable ectomycorrhizal hosts for hypogeous fungi patchily distributed. The species composition of a specific stand reflects the interaction of environmental optima for species, soil factors, pre-glacial flora, extent of glacial advance, pluvial lake levels, and subsequent re-invasion from glacial refugia (Wells, 1983). Another significant factor affecting the presence of hypogeous fungi is the efficiency of mycophagous rodents, and perhaps insects, in spore dispersal.

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[1] Address for correspondence: 2 Canyon Shadows Rd., Lander, WY 82520.

Our survey of the Great Basin and adjacent Cordillera has involved collecting in a large number of habitats. One of the most interesting and difficult habitats to collect is the Interior Chaparral (133.3) vegetation-type (Fig. 1) (Brown, 1994). This vegetation-type is widely scattered along the forest islands comprising the axial route for conifer re-invasion of the Great Basin in southwestern Utah and extends south into Arizona (Wells, 1983). The stands are usually open becoming quite dense along permanent streams. The larger shrubs reach 2 to 2.5 m in height. We were interested in these stands because they contain Shrub Live Oak (*Quercus turbinella* Greene) a putative host for ectomycorrhizal truffles and false-truffles. The windows for sporocarp production are very limited because the monthly precipitation during the growing season averages between 5 and 16 mm (http://www.utah.com/weather/stgeorge.htm).

Another interesting habitat in the same area is the Great Basin Montane Scrubland (132.1) vegetation-type (Fig. 2) (Brown, 1994). These stands contain the deciduous Gambel's oak (*Q. gambelii* Nutt.) and evergreen mountain mahogany (*Cercocarpus ledifolius* Nutt. in T. & G.) a member of the Rosaceae. Both of these shrubs are putative hosts for ectomycorrhizal hypogeous fungi. Often the stands consist of thickets 1 to 6 m in height. The best collecting is around springs and seeps where the Gambel's oaks are larger, up to 15 cm in diameter, and the stands are more open. The windows for collecting are longer, but sufficient precipitation is often limiting.

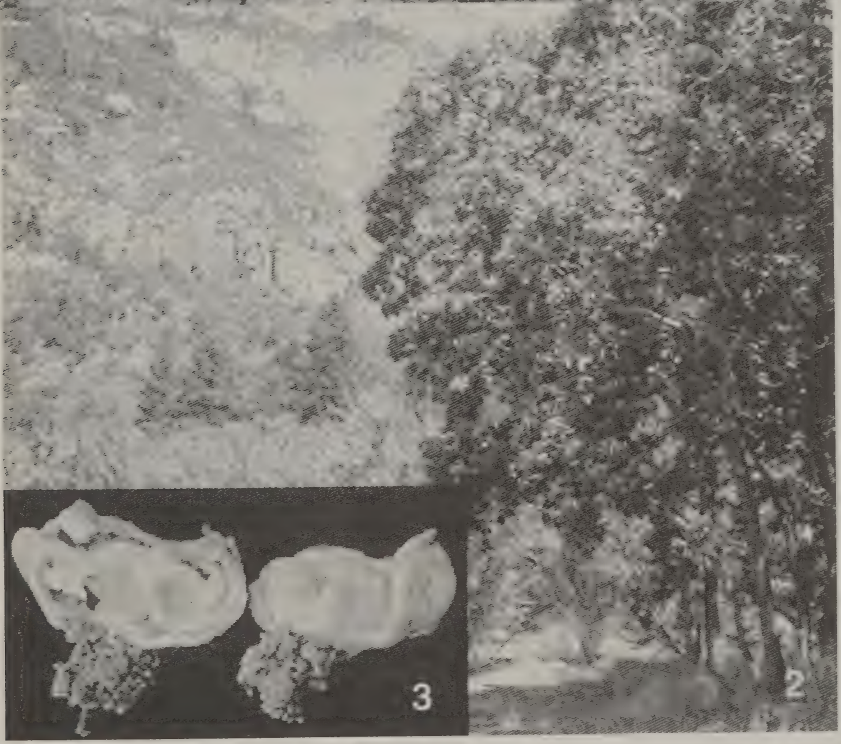
We visited these stands on numerous occasions but rarely collected any hypogeous fungi. The truffle-like *Peziza* described below is one of the hypogeous fungi that we did collect.

MATERIALS AND METHODS

Methods of collection and study of the morphological and anatomical features are essentially those of Smith (Smith and Zeller, 1966). Spores were measured in freehand sections mounted in Melzer's reagent. Lengths and widths of 20 ascospores randomly selected from a mature ascoma in each collection were measured for statistical comparisons. Color names are given as the ISCC-NBS names with the numerical equivalent in parentheses (Kelly and Judd, 1965). Herbarium names are abbreviated according to Holmgren, Holmgren, and Barnett (1990).

Fig. 1. Interior Chaparral (133.3) vegetation-type, Tobin Wash, Utah. **Fig. 2.** Great Basin Scrubland (132.1) vegetation-type, Oak Grove Campground, Utah. **Fig. 3.** Sectioned ascoma, note large locules formed by infolding, Fogel F4971 (MICH).

1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The distribution map was created by using ArcView 3.1 Geographic Information System personal computer software (ESRI Inc., Redlands, California) to overlay coordinates of localities on a political boundary base map. The shaded contour map theme for Utah is an uncompressed TIFF image in 24-bit color from Chalk Butte Inc., Boulder, Wyoming. Specific locality data available from MICH.

TAXONOMIC TREATMENT

PEZIZA QUERCICOLA Fogel & States, sp. nov. Figs. 1-6.

Ascocarpia usque ad 30 x 13 x 15 *mm, profunde sulcata. Peridium glabrum, album, lutescens. Loculi magnum, cavus. Asci cylindrici, octospori, amyloidei (fortissime ad apices), ad apices indentati. Sporae ellipsoideae, 13-17(-19) x 10-13 µm, ornamentis verrucarum ≤0.2 um, hyalinae, uniguttulatum. Paraphyses 6-8 µm in diam., apicibus clavatis. Holotypus: USA, Utah: Kane Co., 22 May 1995, Fogel F4968 (MICH).*

Etymology: Dweller in *Quecus* (oak) forests.

Ptychothecia of irregular symmetry, oblong to turbinate, up to 30 x 13 x 15 mm; multichambered, chambers empty, formed from infolding of ascoma wall, opening to chambers not apparent, lined by a farinose, white to translucent hymenium. Ascoma wall 1 mm thick, fleshy, brittle; abhymenium white with brilliant yellow patches (83) or bruising brilliant yellow, glabrous, farinaceous at X10. Medullary excipulum white, turning brilliant yellow when sectioned. Hymenium white. Attached by a prominent basal tuft of hyphae holding a small "button" of soil. Odor fungoid to strong, sweet, phenolic or dimethyl sulfide-like.

Ascospores ellipsoid, verruculose, 13-17(-19) x 10-13 µm, mean length 15.5 ± 0.8 µm; width 11.2 ± 0.7 µm, length to width ratio 1.39 ± 0.1 µm, n=140 spores from 7 collections, wall 0.5 µm thick including ornamentation; ornamentation of warts ≤ 0.2 um tall, weakly cyanophilic; containing a single large guttule. Asci arranged in palisade, cylindrical, 156-198 x 13-15 µm, operculate with 8 uniseriate spores, opercula 7-8 µm broad, indented tip and apical pore blue in Melzer's reagent, immature asci dextrinoid (dark orange), 17-25 µm broad; walls thin; croziers lacking. Paraphyses filamentous, capitate, tip 9-10 µm broad, stalk 6-8 µm broad, extending slightly past asci (10 µm), not abundant.

Ascomata walls 550-650 µm thick, no clear demarcation between ectal excipulum and medullary excipulum; surface sparsely covered with short, blunt, hyaline hairs, terminal cell 15-30 x 8 µm; context pseudoparenchymous, cells of hyaline, thin-walled, 5-6 µm broad hyphae swelling to 20-30 x 21-23 µm.

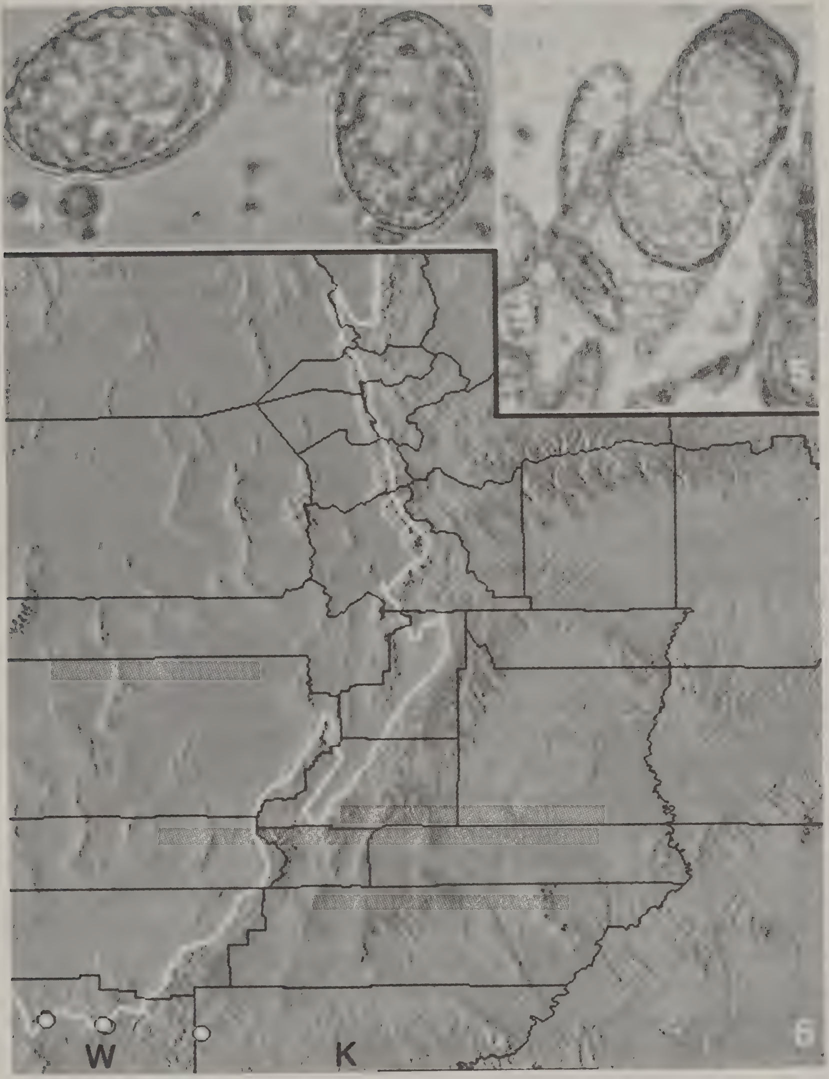

Fig. 4. Spores mounted in Melzer's reagent, 1600X, Fogel F4968. **Fig. 5.** Ascus tip bluing in Melzer's reagent, 1600X, Fogel F5294. **Fig. 6.** Distribution of *Peziza quercicola* in southwestern Utah, USA. Outline (white) of Great Basin in upper left superimposed on political boundaries (black) and shaded topography. Large low relief areas inside the white outline are dry, pluvial lake beds. Mapped localities are in Washington (W) and Kane (K) Counties.

Material examined: USA, **UTAH, Kane Co.**, Fogel F4968 (Holotype). **Washington Co.**, Fogel F4851, F4852, F4881, F4907, F4908, F4971, F5225, F5294 (all MICH).

Putative mycorrhizal hosts and phenology: Hypogeous most commonly under Shrub Live Oak (*Q. turbinella*) in the Interior Chaparral (133.3) vegetation-type, found less frequently under Gambel's oak (*Quercus gambelii*) in the Great Basin Montane Scrubland (132.1) vegetation-type (Brown, 1994). Fruiting from early May to late June at 1300-1800 m elevation in southwestern Utah (Fig. 6).

Discussion: Two of the collections examined, F4852 and F5225, were immature but matched the description of *Peziza quercicola* in every other detail. F4968 was the most mature collection and had larger spores on average than the other collections

The ellipsoid, uniguttulate spores suggest *Peziza quercicola* is more closely related to *P. shearii* (Gilkey) Korf, *P. whitei* (Gilkey) Trappe, *P. stuntzii* Trappe and *P. ellipsospora* (Gilkey) Trappe than either *P. sparassiformis* (Henn. in Warb.) Sacc. & Syd. in Sacc. or *P. proteana* (Boud.) Seaver. *P. shearii* from Virginia differs from *P. quercicola* in having subglobose spores (l/w = 1.1-1.2 vs. 1.39) with large tubercules. *P. whitei* has shorter, narrower spores (11.3-14.0 x 8.1-11.3 µm) and is only known from Australia and New Zealand. *P. stuntzii* from central Washington State differs macroscopically in having a solid gleba and pink flesh. The spores of *P. stuntzii* are ornamented with cyanophilic warts and short ridges. *P. ellipsospora* from California and Oregon has "purplish brown" ascoma, smaller spores ("14 x 10 µm" vs. 13-17(-19) x 10-13 µm), taller ornamentation (≤ 1.0 µm vs. ≤ 0.2 µm) and narrower paraphyses (2-5 µm vs. 6-8 µm, swelling to 9-10 µm broad at tip).

Arora (1986) describes a "*Peziza* sp. (unidentified)" from under oaks in coastal California that might be our *P. quercicola*. His photograph on p. 822 very closely resembles *P. quercicola*. Analysis of fossil packrat middens provides evidence for a much wider distribution of *P. quercicola* than our collecting indicates (Fig. 6). *P. quercicola* may have accompanied the northward spread of oaks during the late Wisconsin and early Holocene (Spaulding 1990) into the Great Basin. Contact between oaks in the Great Basin and California could have occurred at this time. Piñon pine (*Pinus monophylla* Torr. & Frėm.) another member of the Mojavean Woodland grew on the west side of the Sierra Nevada in the late Wisconsin (Spaulding, 1990).

The addition of *Peziza quercicola* to a growing list of sparrassoid and ptychothecial taxa in *Peziza* raises questions about relationships within the Pezizaceae. *Peziza* is a large, common genus producing mostly epigeous apothecia that forcibly release spores to the atmosphere. There are taxa however that produce ptychothecia (sparassoid ascomata) characterized by infolding of the hymenium to produce a urnulate to turbinate or more-or-less spherical ascoma (Korf, 1973). The ptychothecia may be rather loosely folded, creating empty chambers, or more compact, with veins of fertile tissue opening externally. Trappe (1979) states that there are six hypogeous to subhypogeous *Peziza* taxa reported from North America, Europe, Australia, and New Zealand. Castellano et al. (1989) report that there are at least three hypogeous species in North Temperate forests. Two of these in western North America. All are ptychothecial. The stereothecial *Cazia flexiascus* Trappe was recently transferred to the Pezizaceae after 18S and 28S rDNA sequences were analyzed (O'Donnell et al., 1997). The Pezizaceae thus contains apothecial, ptychothecial and stereothecial taxa. Asci forcibly discharge spores or are indehiscent.

It is tempting to hypothesize an evolutionary series from apothecial *Peziza* taxa through ptychothecial taxa with a small number of large open chambers (e.g., *P. quercicola*), ptychothecial taxa with complex folding and small chambers (e.g., *P. stuntzii*) culminating in stereothecial taxa (e.g., *Cazia*). A similar evolutionary "series" has been reported in the Pyronemataceae from apothecial taxa (e.g., *Humaria, Hydnocystis*) to ptychothecial taxa (e.g., *Geopora, Labyrinthomyces, Paurocotylis, Petchiomyces*). It is also tempting to hypothesize that loss of active spore discharge is correlated with ascomata type. Trends in spore discharge are unclear in the Pezizaceae. The epigeous ptychothecial taxa have forcible spore discharge. The mechanism in *P. stuntzii* is unclear although it has indented tips structured for opercula. *P. quercicola* is operculate, but spore release, "puffing", has not been observed. The mechanism in *Cazia* is unknown, although the rounded, entire tip in the micrograph published by Trappe (1989) suggests it is indehiscent. No correlation exists between ascomatal type and spore discharge mechanism in the Pyronemataceae. *Geopora* forcibly discharges spores. *Hydnocystis, Labyrinthomyces, Paurocotylis* and *Petchiomyces* have indehiscent asci. Clearly, the presence of indehiscent asci and epigeous ascomata are not sufficient on their own to separate taxa into families.

Although these extant taxa may represent steps in an evolutionary series from apothecia containing operculate asci to stereothecia containing indehiscent asci, they are the result of evolution not "missing links." Elucidation of evolutionary relationships within the Pezizaceae and Pyronemataceae awaits phylogenetic analysis utilizing molecular data, at least in part.

ACKNOWLEDGMENTS

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MYCOTAXON

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MATERIALS FOR A HYPOGEOUS MYCOFLORA OF THE GREAT BASIN AND ADJACENT CORDILLERAS OF THE WESTERN UNITED STATES. VIII: PACHYPHLOEUS LATERITIUS SP. NOV. AND CAZIA QUERICOLA SP. NOV. (ASCOMYCOTA, PEZIZALES)

Robert Fogel
University of Michigan Herbarium, North University Building,
Ann Arbor, MI 48109-1057

Jack States
Botany Department, University of Wyoming, Laramie, WY 82071[1]

ABSTRACT

Two new taxa, *Pachyphloeus lateritius* and *Cazia quericola,* associated with *Quercus turbinella* and *Pinus edulis* from southwestern Utah, United States, are described and illustrated.

Key Words: truffle, Utah, biogeography.

This is the eighth in a series containing materials for a hypogeous mycoflora of the Great Basin and adjacent Cordilleras (Fogel 1994, Fogel and Pacioni, 1989). The region has received little attention from mycologists despite its potential for studies of fungal biogeography, evolution, and coevolution. The Great Basin, as defined by Cronquist et al. (1972), occupies an area of 714,854 square km. The species composition of a specific stand reflects the interaction of environmental optima for species, soil factors, pre-glacial flora, extent of glacial advance, pluvial lake levels, and subsequent re-invasion from glacial refugia (Wells, 1983).

The vegetation in the region contains many suitable ectomycorrhizal hosts for hypogeous fungi. One of the most interesting and difficult habitats to collect is the Interior Chaparral (133.3) vegetation-type (Brown 1994). This vegetation-type is widely scattered along the forest islands comprising the axial route for conifer re-invasion of the Great Basin in southwestern Utah and extends south into Arizona (Wells, 1983). The stands are usually open becoming quite dense along permanent streams. The larger shrubs reach 2 to 2.5 m in height. Shrub live oak (*Quercus turbinella* Greene), a putative host for ectomycorrhizal truffles and false-truffles, is one of the dominant shrubs. Collecting in these stands has produced a number of interesting truffles including the new *Pachyphloeus* and *Cazia* taxa described below and *Peziza quercicola* described earlier (Fogel and States, 2002).

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[1] Address for correspondence: 2 Canyon Shadows Rd., Lander, WY 82520.

The apparent high degree of endemism suggested by the three new taxa being from the same stand may only reflect the lack of collecting in this vegetation type.

MATERIALS AND METHODS

Methods of collection and study of the morphological and anatomical features are essentially those of Smith (Smith and Zeller, 1966). Spores were measured in freehand sections mounted in Melzer's reagent. Lengths and widths of 20 ascospores randomly selected from a mature ascoma in each collection were measured for statistical comparisons. Color names are given as the ISCC-NBS names with the numerical equivalent in parentheses (Kelly and Judd, 1965). Herbarium names are abbreviated according to Holmgren, Holmgren, and Barnett (1990).

TAXONOMY

PACHYPHLOEUS LATERITIUS Fogel & States sp. nov. Figs. 1-4

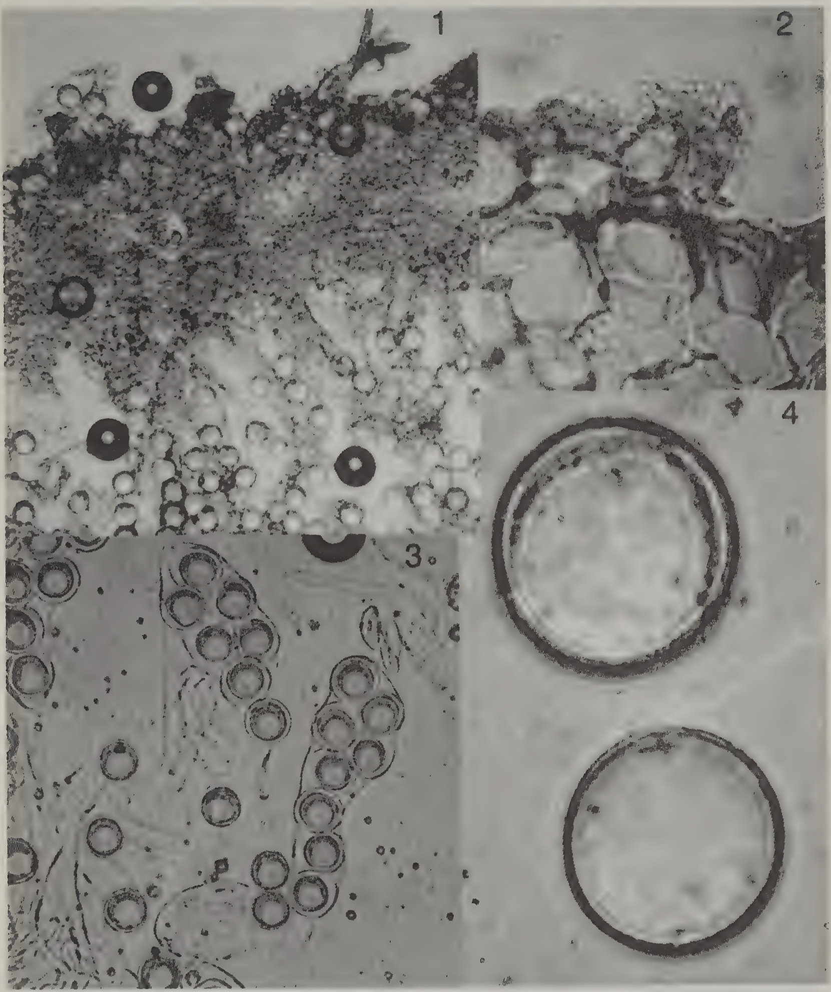
Pytchothecia usque ad 33 x 28 mm, subglobosum ad cerebriformum, sulcata. Peridium glabrum, lateritium. Gleba album. Asci saccati, quadrispori ad octospori, non-amyloidei. Sporae globosoideae, 18-27 µm, ornamentis echinulatum, ≤0.5 um, hyalinae, uni-guttulatum. Paraphyses 4 µm in diam., apicibus rotundatum. Holotypus: USA, Utah: Kane Co., 13 May 1995, Fogel F4887 (MICH).

Etymology: lateritius (L.) dark brick color, in reference to the color of the peridium.

Pytchothecia subglobose to craniform, deeply furrowed with invaginations on apices, up to 33 mm wide x 28 mm high, light yellow brown (ISCC-NBS 76), strong brown (ISCC-NBS 55) to deep brown (ISCC-NBS 56) with strong red tones, to dark grayish brown (ISCC-NBS 62), granulose with small dark brown warts, sparsely tomentose. Gleba solid, white (ISCC-NBS 263), veins suggested in dried pytchothecia by slight depressions or wrinkles. Hymenium irregular, interrupted by sterile veins. Attached by a single 0.5 mm diam. rhizomorph. Odor not noted.

Spores globose, 18-27 µm diam., averaging 19.95 ± 1.00 µm, hyaline, immature spores dextrinoid, ornamented with mucilage-embedded spines <0.5 µm long, wall 1 µm thick including mucilage. Asci broadly clavate, 85-120 x 35-45 µm wide, non-bluing (I), immature asci dextrinoid, containing 4 uniseriate to 8 biseriate spores, base stalked, buried in sinuous 4 µm diam. septate paraphyses. Tips of paraphyses rounded, not swollen, projecting beyond the asci.

Ectal excipulum 80-100 µm thick, composed of subglobose to radially elongate, 17-35 µm long x 12-30 µm wide, thick-walled (1 µm) cells, walls dull orange to brownish black (KOH and I). Parenchymous below, cells hyaline, grading into a 100 µm thick layer of periclinal, hyaline, 4-5 µm diam. hyphae, some cells inflated to 8 µm. Content of some cells in the



Figs. 1-4. *Pachyphloeus lateritius*. Fogel F4981 (MICH). **Fig. 1.** Ectal excipulum and gleba mounted in Melzer's reagent, 118X. **Fig. 2.** Thick walled cells on surface of ectal excipulum mounted in KOH, 640X. **Fig. 3.** Asci mounted in KOH, phase contrast, 235X. **Fig. 4.** Spores mounted in Melzer's reagent, 1600X.

center of sterile veins dull orange (I). Warts 100 µm wide x 80 µm high composed of thick-walled dull orange, elongate cells. A few thick-walled (1 µm), straight, 6-8 µm diam. hairs projecting from the peridium.

Putative mycorrhizal hosts and phenology: Fruiting from mid May to late June at 1300-1400 m elevation in southwestern Utah. Two of the collections were hypogeous under shrub live oak (*Q. turbinella*) in the Interior Chaparral (133.3) vegetation-type (Brown, 1994). One collection was hypogeous under Rocky Mountain piñon pine (*Pinus edulis* Engelm.) in the Great Basin Conifer Woodland (122.4) vegetation-type, one of the most common types in the Intermountain Region (Brown, 1994).

Material examined: USA, **Utah, Kane Co.**, Fogel F4969. Washington Co., Fogel F4887 (Holotype), F4981 (all MICH).

Discussion: *Pachyphloeus lateritius* is easily mistaken for a *Balsamia* due to the reddish brown color and warted peridium. Under the microscope, the globose spores easily distinguish this taxon from *Balsamia*.

Three species of *Pachyphloeus* are known from North America (Gilkey, 1954; Castellano et al., 1989). Two of them (*P. virescens* and *P. melanoxanthus*) have green to greenish-black ascoma. *P. citrinus* has orange to brown ascoma. The spores of the latter have low, truncate papillae clearly distinct from the echinulate spores of *P. lateritius*. *P. citrinus* also has larger diam. paraphyses (8-13 vs. 4 µm) and smaller globose spores (8-13 vs. 18-27 µm).

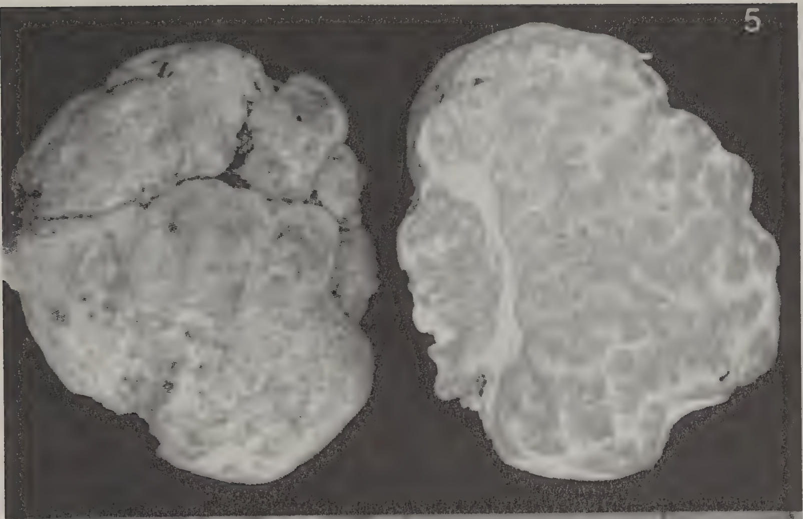
CAZIA QUERICOLA Fogel & States Figs. 5-10

Sporocarpia usque ad 35 x 30 x 28 mm, cerebriformum, prope album, subtomentum. Gleba album ad pallide violaceo-grise. Asci 120-170 x 14-30 µm, sporis 8, irregulatim cylindrici vel saccati, plerumque flexi, hyalini, non-amyloidei. Sporae 11-14 x 10-12 µm, subglobosae, hyalinae, minute verrucose reticulatae, ornamentum <0.5 µm altum. Holotypus: USA, Utah: Washington Co., 22 May 1995, Fogel F4909 (MICH).

Etymology: cola (L.) dweller, hence dweller in *Quercus* forests.

Stereothecia up to 35 x 30 x 28 mm high, craniform with several basal lobes; white (ISCC-NBS 263) bruising brownish orange (ISCC-NBS 54); subtomentose, larger stereothecium with cracks from rapid expansion; attachment not evident. Gleba dense, very firm but sectioning easily, fertile

Figs. 5-9. *Cazia quericola*. **Fig. 5.** Sectioned sporocarp, 1.5X, Fogel F4878 (MICH). **Fig 6.** Asci mounted in KOH, note crozier, phase contrast, 1400X, Fogel F4909 (MICH). **Fig. 7.** Uniseriate and biseriate asci and septate paraphyses mounted in KOH, note bending of asci, phase contrast, X166, Fogel F4909. **Fig 8.** Spores mounted in Melzer's reagent, 1600X, Fogel F4909. **Fig. 9.** Isodiametric cells in trama, squash mount in Melzer's reagent, 1600X, Fogel F4909.



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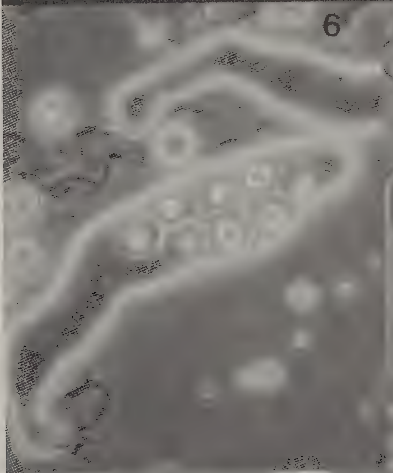

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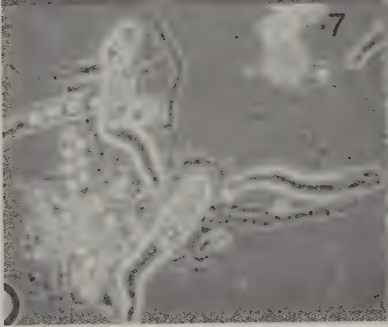

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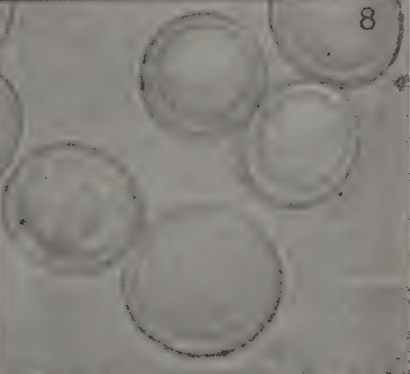

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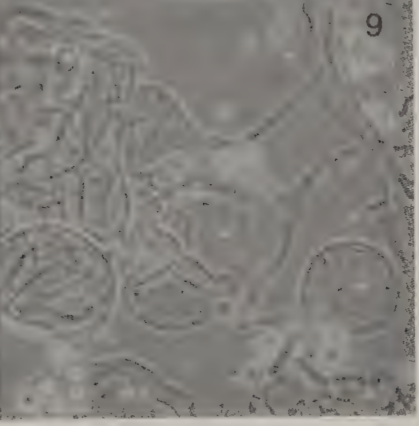

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areas white (ISCC-NBS 263) to pale reddish purple (ISCC-NBS 244), empty or stuffed with white hyphae dried. Trama white, drying moderate to dark orange yellow (ISCC-NBS 71-72), radiating outward from basal patch, 300-350 µm wide, composed of hyaline, thin-walled, subparallel hyphae; 6-10 µm wide at septa, cells inflated to 18 µm. Color changes on application of chemicals not noted. Attachment not obvious. Odor faintly *Tuber*-like.

Spores globose to mostly subglobose 11-14 x (9-)10-12 µm averaging 12.2 ± 0.8-0.9 x 10.9 ± 0.9 µm to 11.6 ± 0.5, Length/Width ratio 1.06-1.12, hyaline, uniguttulate, immature spores dextrinoid, incompletely warty-reticulate, warts <0.5 µm high, non-amyloid, wall 1-1.5 µm thick including ornamentation. Asci in pockets of thin-walled, 40-65 µm diam. cells; asci cylindrical to saccate, mostly bent, 120-170 x 14-30 µm, immature asci dextrinoid; 8-spored, uniseriate to mostly irregularly biseriate; base tapered, obscurely croziered. Paraphyses 6-8 µm diam, septate, terminal cells 20-25 µm long, tips swollen to 10 µm.

Peridium 175-425 µm thick, outer layer of periclinal, dextrinoid, 5-8 µm diam hyphae, some cells swollen to 15 µm diam; interrupted occasionally by 20-30 µm isodiametric cells. Cells smaller near the surface and more parenchymous

Putative mycorrhizal hosts and phenology: Fruiting mid to late May at 1400 m elevation in southwestern Utah. Hypogeous under shrub live oak (*Q. turbinella*) in the Interior Chaparral (133.3) vegetation-type (Brown, 1994).

Material examined: USA, **Utah, Washington Co.**, Fogel F4878, F4909 (Holotype) (all MICH).

Discussion: Fruiting in the same stand of *Q. turbinella* as *Pachyphloeus lateritius.* The color of the gleba may depend on maturity. The immature gleba was pale reddish purple, the mature gleba was white. The gleba of *C. flexiascus* is described by Trappe (1989) as "light purplish gray (ISCC-NBS 232)". *Cazia* may be associated with oaks as both *C. quericola* and *C. flexiascus* were collected under *Quercus* species.

Differentiated from *C. flexiascus* by having smaller subglobose, rather than ellipsoid, spores (11-14 x 10-12 µm vs. "13-16 x 10-12 µm"; L/W 1.1 vs. 1.3). The paraphyses are also narrower (6-8 µm, apices swelling to 10 µm vs. "7-10 µm", apices swelling to "15 µm") and peridium thicker (175-425 vs. "100-150 µm").

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MYCOTAXON

Volume LXXXI, pp. 91-94 January-March 2002

A NEW INONOTUS (BASIDIOMYCOTA, HYMENOCHAETACEAE) FROM HAWAI‘I

Robert L. Gilbertson
Department of Plant Pathology, University of Arizona, Tucson, AZ 85721

and

Leif Ryvarden
Department of Botany, Biol. Inst., University of Oslo, Oslo, Norway

ABSTRACT

Inonotus hemmesii is described as a new species causing a white heartrot of living hardwoods in the Hawaiian Islands. It is characterized by large pileate basidiocarps, frequent setal hyphae in the tube trama, rare hymenial setae, and pigmented, ovoid to ellipsoid basidiospores.

This paper reports a previously undescribed species in the genus *Inonotus* P. Karst. It is associated with a white heartrot of koa and some introduced hardwoods in the Hawaiian Islands. Current records are from the islands of Hawai‘i, Moloka‘i, and O‘ahu, and it is particularly common on mānele (*Sapindus saponarius* L.) on the island of Hawai‘i.

INONOTUS HEMMESII Gilb. & Ryvarden, sp. nov. Fig. 1
Fructificatio annua, pileata, sessile vel effuso-reflexa; systema hypharum monomiticum; hyphae setarum frequenter adsunt in trama; setae hymeniarum rara; basidia late ellipsoideae, 4-sterigmatibus, 12-15 x 8-10 µm; basidiosporae ovoideae vel ellipsoideae, pallido-brunnea, crassitunicatae, 7.5-9 x 5.5-7 µm; putrido alba. Holotype: RLG 22943, on *Delonix regia*, Kaunakakai, island of Moloka‘i, Hawai‘i, Jan. 7, 2000, in herb. BPI, Beltsville, MD.
Etymology: named in honor of Dr. Don E. Hemmes, University of Hawai‘i at Hilo, who has contributed greatly to knowledge of Hawaiian fungi.

Basidiocarps annual, pileate, sessile to effused-reflexed, up to 30 x 20 x 15 cm; pilear

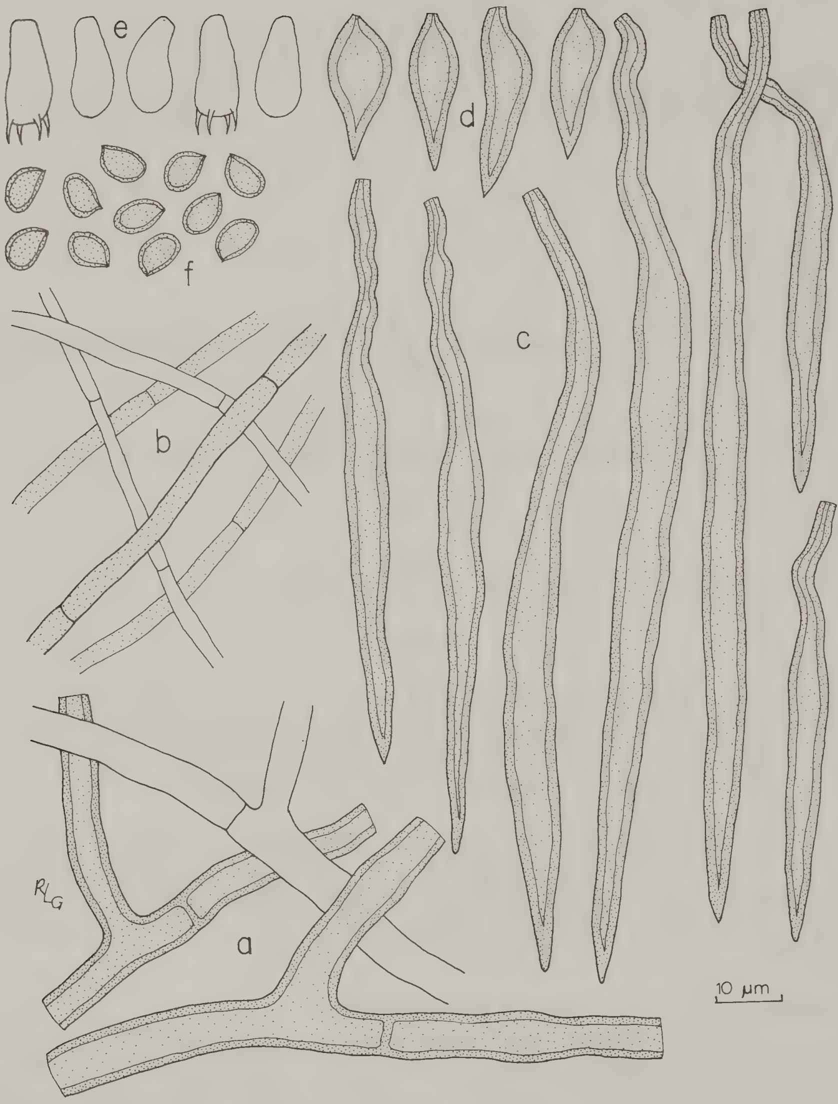

Fig. 1. Microscopic characters of *Inonotus hemmesii* (RLG 22943). a, contextual hyphae; b, tramal hyphae; c, tramal setal hyphae; d, hymenial setae; e, basidia, f, basidiospores.

surface brown, shallowly sulcate, zonate, finely tomentose at first, becoming glabrous to crustose and finally blackened and rimose with age; pore surface yellowish brown at first, becoming darker brown with age, the pores angular, regular, 3-4 per mm, dissepiment edges finely granular under 30x lens; context tough-corky, with a thin tan upper layer up to 2 mm thick and a dark chocolate brown lower layer up to 6 cm thick; tube layer distinct, yellowish-brown, up to 4 cm thick.

Hyphal system monomitic; contextual generative hyphae pale yellowish to darker yellowish brown in KOH, thin- to firm-walled, simple-septate, of two types; predominant type long, rarely branched, 7-10 μm in diam, these interlaced with narrower, much-branched and contorted hyphae 3-5.5 μm in diam; tramal hyphae of one type, pale golden brown, parallel, with occasional branching, thin- to firm-walled, simple-septate, 3-5.5 μm in diam.

Setal hyphae frequent in trama, absent in context, becoming thick-walled, dark reddish brown in KOH, 7-10(-12) μm in diam and up to 170 μm long, tapering to a point, not projecting into hymenium.

Hymenial setae rare, absent in many sections, ventricose, thick-walled, pointed, dark reddish brown in KOH, 20-25 x 7.5-10 μm.

Basidia broadly ellipsoid, 4-sterigmate, 12-15 x 8-10 μm, simple-septate at the base.

Basidiospores invariably present in large numbers, even in old specimens, ovoid to ellipsoid, pale golden brown in KOH, smooth, becoming thick-walled, negative in Melzer's reagent, 7-9 x 5.5-7 μm.

Specimens examined: RLG 17634, on koa (*Acacia koa* A. Gray), Keanakolu Rd., North Hilo Dist., Hawai'i, Aug. 29, 1991; RLG 18037, 18046, on mānele (*Sapindus saponarius* L.), Kīpuka Kī, Hawai'i Volcanoes National Park (HVNP), Ka'ū Dist., Hawai'i, Sept. 22, 1991; RLG 18364, 18369, on koa, Manoa Cliffs Trail, Honolulu Dist., O'ahu, Oct. 6, 1991; RLG 18728, on mānele, Kīpuka Kī, HVNP, Ka'ū Dist., Hawai'i, Oct. 24, 1991; RLG 19355, on mānele, Kīpuka Kī, HVNP, Ka'ū Dist., Hawai'i, Dec. 5, 1991; RLG 21419, on royal poinciana (*Delonix regia* (Bojer) Raf.), Kaunakakai, Moloka'i, Jan. 13, 1996; RLG 22363, on mānele, Kīpuka Kī, HVNP, Ka'ū Dist., Hawai'i, Nov. 22, 1998; RLG 22943, on royal poinciana, Kaunakakai, Moloka'i, Jan. 7, 2000 (TYPE).

Inonotus hemmesii is close to *I. rodwayi* D.A. Reid (Reid, 1957) but differs in having wider, more thick-walled basidiospores. Also, the setal hyphae in the trama of *I. hemmesii* are longer, consistently imbedded and not projecting into the tubes. Those of *I. rodwayi* are shorter and often project into the tubes. *Inonotus patouillardii* (Rick) D.A. Reid is also similar but the setal hyphae of that species are abundant, very conspicuous in all sections, and often project up to 100 μm beyond the hymenium (Gilbertson and Ryvarden, 1986). Setal hyphae of *I. hemmesii* are frequent but not abundant and may be absent in some sections. Also, the basidiospores of *I. patouillardii* (4.5-6 x 3.5-4.5 μm) are smaller than those of *I. hemmesii* (7-9 x 5.5-7 μm).

ACKNOWLEDGMENTS

Mahalo to Don Hemmes for his expertise and the pleasure of his company in field work in the Hawaiian Islands over the past eleven years.

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PHAEOCOLLYBIA IN WESTERN NORTH AMERICA 3: TWO NEW SPECIES WITH NOTES ON THE PHAEOCOLLYBIA FESTIVA COMPLEX[1]

LORELEI L. NORVELL[2]
Pacific Northwest Mycology Service
6720 NW Skyline Boulevard, Portland OR 97229-1309 USA

Abstract: Morphological and molecular reevaluation of the genus *Phaeocollybia* has uncovered the existence of two new forest agarics from British Columbia, Washington, Oregon, and California. *Phaeocollybia phaeogaleroides* produces small, fragile basidiomes with large, lightly ornamented, ellipsoid basidiospores, abundant clamp connections, and a unique fruiting phenology. First revealed during molecular analyses, *Phaeocollybia rifflipes* produces small basidiomes with tawny viscid pilei and lilac-colored lamellae. It shares affinities with two western species (*Phaeocollybia fallax* and *Phaeocollybia lilacifolia*) with glutinous pilei, lilac lamellae, vertical-monopodial pseudorhizae, limoniform basidiospores, and thin-walled clavate cheilocystidia. The close morphological relationship of three western species to the European *Phaeocollybia festiva* is discussed.

Key words: Agaricales, Basidiomycota, Cortinariaceae, RFLP, temperate rainforest

Introduction

Over one thousand *Phaeocollybia* (Basidiomycota, Cortinariaceae) collections have been made from the northern temperate rainforests of the western American coast as part of a continuing study of the genus begun in 1991. This research has resulted in the discovery of generically significant morphological characters (*e. g*. universal pellicular sheath, different pseudorhizal morphologies, sarcodimitism, *cf.* Norvell 1998ab), molecular support for the existence of 25 species (inferred from restriction digests of 160 collections, *cf.* Norvell 1998a, 2000), new insights into the development and biology of the genus (Norvell 1998ab), and naming of five new species (Norvell 2000, Norvell & Redhead 2000). Two additional new species -- *P. phaeogaleroides* and *P. rifflipes* -- are proposed and described, and *P. rifflipes* is compared to species sharing affinities with *P. festiva* (Fr.) Heim.

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[1] Based in part on material submitted for a doctoral dissertation at the Department of Botany, Box 355325, University of Washington, Seattle WA 98195-5325 USA.

[2] *Email:* <lorelei@teleport.com>

Materials and Methods

Specimen collection and examination, macrochemical tests, DNA extractions, PCR amplification of the ITS1+5.8S+ITS2 rDNA region (hereafter referred to as the "ITS region"), and phenetic and phylogenetic analyses were conducted using protocols previously summarized in Norvell (1998ab, 2000).

Descriptions are based on data taken from both type and other well-documented collections. Generic or developmental terms (*e.g.* tibiiform diverticula, sarcodimitic tissues, pellicular veil, vertical-monpodial) are fully explained in Norvell (1998ab). General non-standardized color names in lower case are accompanied by italicized color references. Ridgway (1912) colors are capitalized and abbreviated, with a slash (/) or parentheses separating modifiers of the same base color (*e.g. Mikado /Mars /Verona Brown = Mikado Brown, Mars Brown, Verona Brown; (Pale) Pinkish Cinnamon = Pale Pinkish Cinnamon* and *Pinkish Cinnamon);* bracketed Munsell (1976) alpha-numeric color ranges (*e.g. [2.5Y 6-8/1-4]*) follow Ridgway (1912) references. Measurements of anatomical characters were taken from tissues rehydrated in 6% aqueous KOH unless otherwise noted, and basidiospores from the stipe apex were measured when spore prints were lacking. Mean basidiospore dimensions with standard deviations are accompanied by ranges enclosed in parentheses. "L+ll/cm" is the number of lamellae + lamellulae per cm at the "edge" of the pileus and at the "midpoint" between edge and stipe. "Aerial stipe" refers to the portion of the stipe above the ground; "origin" refers to the pseudorhizal origin at the very base of the basidiome.

Herbaria housing cited collections are abbreviated in accordance with Holmgren et al. (1990), with "PNW" representing the Pacific Northwest Mycology Service herbarium. RLFP codes are denoted by subscripts, and asterisks (*) flag Northwest Forest Plan Strategy 3 collections (USDA-USDI 1994, Norvell 1998c) that are of significance to US forest management policy. Separate collection dates are not listed for the date-based numbered Norvell collections *e.g.* LLN1921104-2$_{\text{riu10}}$ = Norvell *November 4, 1992* collection *2*, RFLP code *riu10*).

Taxonomic Descriptions

Phaeocollybia phaeogaleroides Norvell *sp. nov.* FIGURES 1-2

Pileus 13-50 mm latus, e convexo campanulatus et umbonatus, glaber, viscidulus, hygrophanus, e fulvo ferrugineus; caro tenue, pallida; odor et sapor lenis; lamellae pallidae vel luteae, fulvo-brunnescentes e sporis; stipes e farcto subcavus, 1.5-4 mm crassus, 60-90 mm longus supra terram usque ad 180 mm longus cum pseudorhiza attenuata, glaber, apice lamellis concolorus et subapice ferruginascentes. Sporae magnae, 9-12 X 5-6.2 µm, ellipsoideae, verruculosae

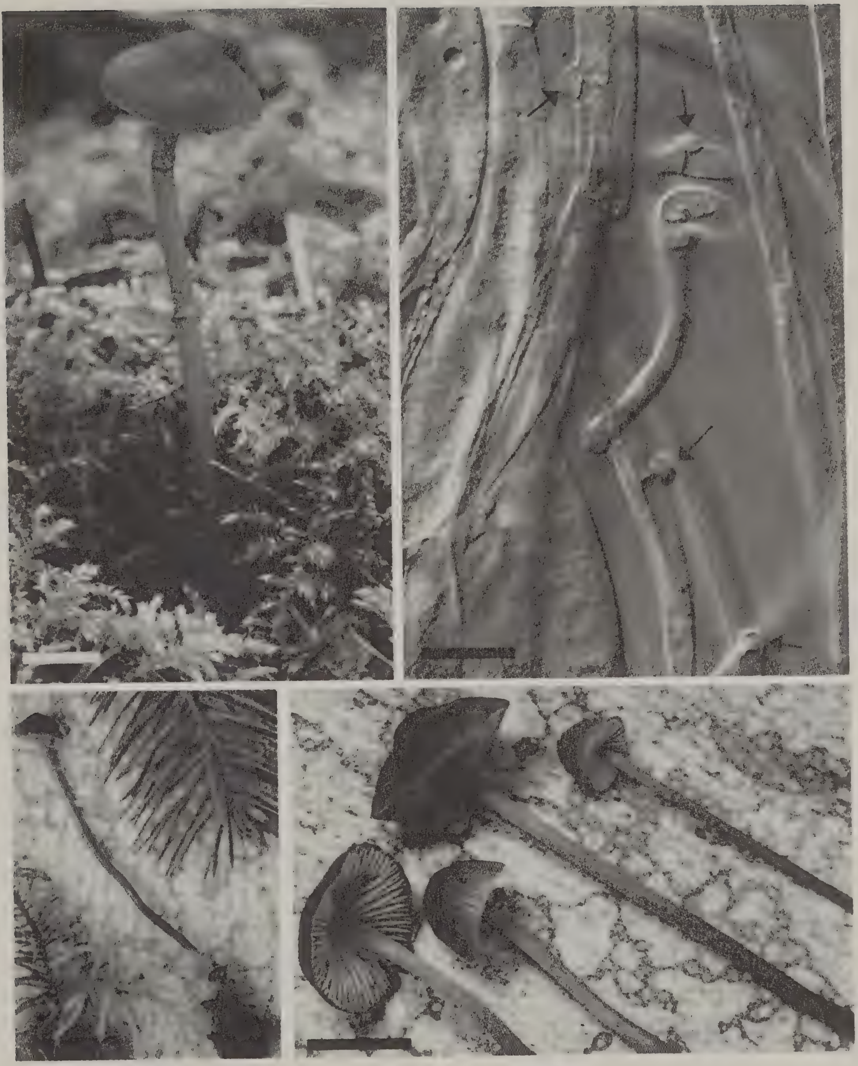

Figure 1. *Phaeocollybia phaeogaleroides.* Fig 1a. LLN1990413-01 (PNW) *in situ* in 50-year old mixed forest in Benton County, Oregon. Note breaks on fragile stipe caused by removal of debris around specimen. Scale bar = 5 mm. Fig 1b. Clamp connections on hyphae in pileus suprapellis in collection from Drift Creek, Oregon (LLN1961101-01, WTU). Scale bar = 10 microns. Fig 1c. Small basidiome (LLN1990421-04, PNW) from Green Peak, Oregon with Douglas-fir branch and moss (*Eurhynchium oreganum*). Fig 1d. Detail of mycenoid holotype specimens (Ex199-064, OSC & PNW) from Alsea Falls, Oregon, showing moist striate pilei. Scale bar = 5 mm.

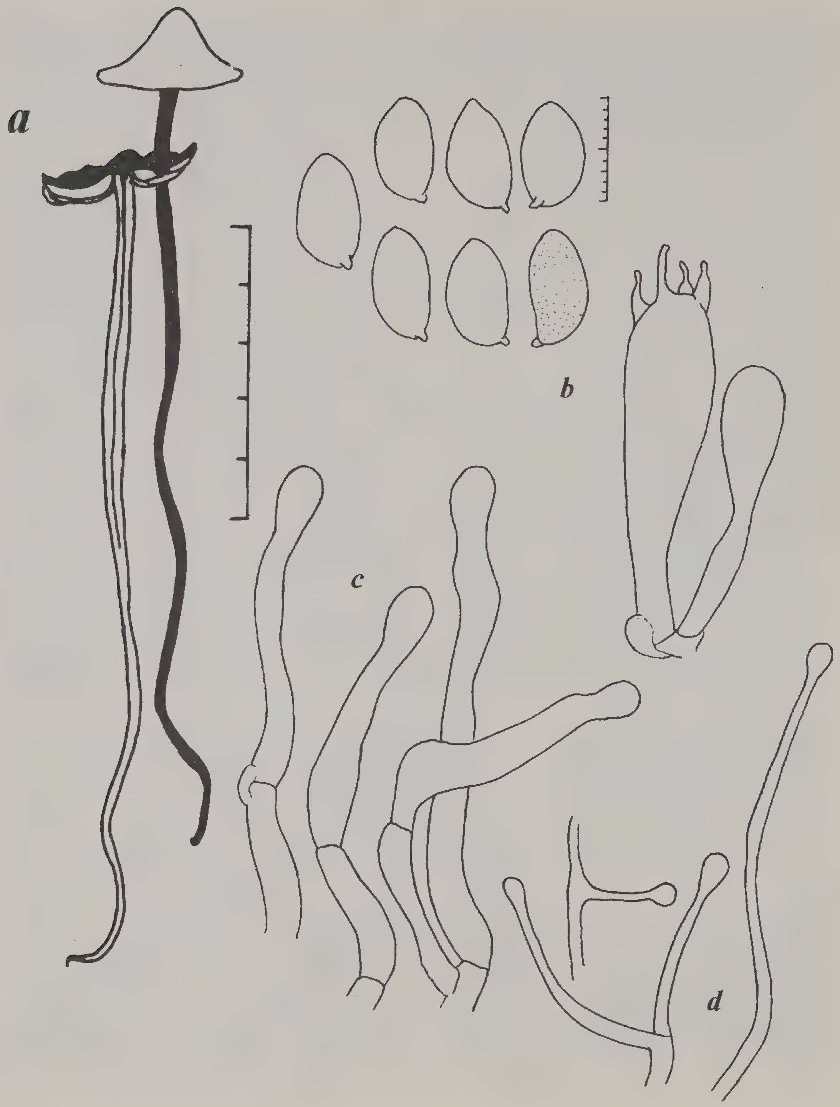

Figure 2. *Phaeocollybia phaeogaleroides.* Fig 2a. Longitudinal section of mature expanded basidiome with dark, moist cuticle (left, adapted from LLN1961106-01 [WTU], collected near Drift Creek, Oregon) contrasts with slightly less mature specimen with fading, hygrophanous pileus (right, adapted from ROuterbridge298 [DAOM], collected on Vancouver Island, British Columbia). Scale bar = 5mm. LLN1951106-01 [WTU]. Figs 2b-d. Scale = 10 microns. Fig 2b. Basidiospores, basidium, and basidiole. Under low magnification, the large, punctate-roughened basidiospores appear almost smooth while the apical callus might be mistaken for a germ pore. Fig 2c. Thin-walled cylindrical to clavate cheilocystidia with clamp connections. Fig 2d. Tibiiform diverticula emanating from hyphae of the sitipitipellis.

subtiliter, cum apice glabro et rotundato vel parum acuto, cum apiculo excentrico glabro et cum plaga obscura; ixocutis cum suprapelle aliquanto, subgelatinosa, hyalina et subpelle cum pigmento subluteo; cheilocystidia cylindracea vel subcapitata, leptoderma, hyalina vel sublutea, 3-5 µm lata; paracystidia filiforma. Hyphis in suprapelle, cheilocystidiae et basidiae fibulati. Diverticula tibiiforma longissima, ad 50 µm longa. Typus *ad terram in musco in sylvis Pinacearum mixtarum: R. L. Exeter Ex199-64, December 7, 1999, Finley Hill BLM Reserve Forest, Mary's Peak RNA, Benton County, Oregon, USA (Holotypus OSC; Isotypi WTU, PNW).*

Etymology: from morphologies shared with the genus *Phaeogalera* (general aspect, basidiospores).

BRIEF SUMMARY – Basidiomes small, fragile, rooting; pilei thin-fleshed, conic to broadly campanulate with low umbo, subviscid, striate, hygrophanous, dark chestnut brown but soon fading to honey-tan; young lamellae pallid to yellow-tan; stipes thin, fragile, cartilaginous, polished, tan to dark brown; pseudorhizae vertical-monopodial with yellowish origins; basidiospores large (~10 X 5.8 µm), ellipsoid with rounded to very slightly pointed (not beaked) apices, faintly verruculose-roughened; cheilocystidia cylindrical to slender subcapitate with slightly thickened and slightly refractive walls; pileipellis bilaminate, with a colorless suprapellis of clamped narrow hyphae overlying a pale orange-yellow subpellis; clamp connections abundant, medallion-like; tibiiform diverticula unusually long (up to 50 µm). All tissues negative in syringaldazine.

EXPANDED TECHNICAL DESCRIPTION – **Pileus** 7-50 mm diam, when young conic-convex with prominent to obscure obtuse umbo, when mature broadly campanulate with/without acute/low umbo and uplifted margin with cuticle extending beyond lamellae at edge; disc sometimes radially rugulose, surface glabrous, moist to subviscid, hygrophanous, when moist long pellucid striate and dark red-brown *(Clay Color [2.5 YR 4-5/6, 5YR 4/4-6, 10YR 3-4/2-4)*, when dry soon fading to honey-tan overall (*Warm Buff, Yellow Ochre [10YR 5-6/4-6]).* **Context:** thin (2 mm at the disc), pallid to pale tan. **Odor** not distinctive to very slightly raphanoid. **Taste** not distinctive. **Lamellae** free to narrowly sinuate attached, subdistant to close, polydymous with 3-5 tiers of +/- regularly interspersed lamellulae, ventricose, 2-6 mm broad (length:width ratio 3.8), thin, edges even to slightly serrulate, pallid, when young pale honey-tan or pallid *(Warm Buff, [10YR 8/4])*, when mature pale rusty brown *([10 YR 5/4]).* **Primordial sheath remnants** occasionally evident as scattered fibrillose patches on stipe. **Stipe** central, terete, slender, cartilaginous rigid but fragile (mycenoid), aerial length 60-90 mm, combined length including pseudorhiza up to 180 mm, apex 1.5-4 mm diam, more or less equal to ground level, glabrous, dry, slightly polished, young apex honey tan *(Warm Buff [2.5Y 5/4, 10YR 6-7/4-6]),* below grading to vinaceous brown *(2.5 YR 5/6, 7.5 YR 4/2, 10YR 3/2, 10YR 5/10)*; stuffed when young, cortex thin (0.5 mm) and cartilaginous, context loosely fibrillose, pallid to pale yellow when young; fistulose in age. **Pseudorhiza** vertical-monopodial, 1/2 - 2/3 overall stipe length, fragile, slightly enlarged just below ground level before gradually tapering to pale yellow *([2.5 YR 6-8/4-6])* origin.

Spore print: reddish brown *(Cacao Brown, [2.5YR 4/4-6])*.

Basidiospores 10 X 5.8 ±0.6 x 0.4 μm (overall range 9-12 (13) x 5-6.5 μm), terete or slightly compressed, ellipsoidal with eccentric apiculus and rounded to slightly pointed (unbeaked) apex; very finely verruculose roughened, the suprahilar disc an ill-defined area of lowered ornamentation faintly discernible in oil immersion; amber in KOH, yellowish in H_2O, inamyloid and nondextrinoid in Melzer's. **Cheilocystidia** emanating from the lamellar trama, cylindrical to subcapitate, long (up to 80 μm), apices either 2-4 μm diam or (occasionally) forming 3-5 μm heads above 2-3 μm diam slightly refractive necks, walls slightly thickened, hyaline to pale orange yellow in KOH, septa with medallion-like clamps, ± agglutinated in revived material. **Pleurocystidia** occasional to infrequent, filamentous or sparsely forked, readily collapsing in mounts and hence very obscure, particularly in revived material. **Basidia** (2-) 4-spored, 28-32 x 8-10 μm, clavate, hyaline, basally clamped. **Pileipellis** bilaminate; the 50-100 μm thick, colorless suprapellis composed of cylindrical, narrow (2-4 μm), thin-walled, (sub)gelatinized, hyaline hyphae, clamp connections frequent; the 150-200 μm thick, pale orange-yellow subpellis composed of 4-8 μm wide gelatinized hyphae. **Stipitipellis** bilaminate, but not well delimited; the colorless suprapellis hyphae tightly packed, 2-4 μm wide, subgelatinized, hyalinel; the subpellis a pale orange-yellow zone of 10-15 μm wide, heavily gelatinized hyphae. **Pseudorhizal pellis** rusty brown, hyphae 5-10 μm wide and moderately thick-walled (0.5 μm); this layer covered by a remaining colorless primordial pellis composed of diverticulate, 2-3 μm wide, gelatinized hyphae. **All tramal tissues** gelatinized and containing occasional oleifers; in the *pseudorhiza* weakly sarcodimitic with long (50-80 μm), wide (10-15 μm), moderately thick walled (0.5 μm), pale amber, rigid, vessel hyphae intermixed with thinner-walled, narrower (2-4 μm), hyaline, flexuous hyphae; in the *stipe* and *pileus* composed of uniformly thin-walled, 4-8 μm wide, pale amber hyphae; in the *lamellae* parallel, the relatively narrow central region composed of moderately thick-walled (0.5 μm), 3-7 μm wide, pale orange-yellow hyphae. **Tibiiform diverticula** found on primordial sheath remnants, frequent on stipitipellis, abundant on pseudorhizal pellis; unusually long (15-50 μm) and wide (1-2 μm) for the genus; usually capitulate with 2-3 μm diam capitellum and/or apical droplet, lacking basal septum; refractive, hyaline. **Clamp connections** medallion-like, present on basidial bases, cheilocystidia, and suprapellicular hyphae.

Macrochemical reactions: *Syringaldazine* negative. *KOH* slightly reddish brown. *FeSO4* greenish. **Fluorescence** absent in fresh material; dried lamellae bright yellow orange. **RFLP profile** not tested

Ecology, range, distribution, phenology: solitary, scattered, or closely gregarious in mossy low lying areas near or under mid-/late-successional conifers such as *Pseudotsuga menziesii* (Mirbel) Franco, *Picea sitchensis* (Bong.) Carr., *Tsuga heterophylla* (Raf.) Sarg. Known from 19 collections made in Oregon and British Columbia. Autumn through early summer (October to July).

> **SPECIMENS EXAMINED: CANADA. British Columbia. Vancouver Isl.** Fairy Lake, Hwy 24. Plot UK Fd 98-8 – solitary on ground in 35yo *Pseudotsuga menziesii* stand, no understory/vegetation in immediate vicinity, 21.VII.1997 *ROuterbridge109* (DAOM); Plot #2 – 20.X.1997 *ROuterbridge298* with SARedhead (DAOM). **UNITED STATES. Oregon. Benton Co.** Finley Hill BLM Reserve, Mary's Pk RNA – in moss-covered loam in second growth *Pseudotsuga menziesii*, 7.XII.1999, RLExeter *Ex199-64* (HOLOTYPE OSC; Isotypes – WTU, PNW); Mary's Pk RNA (T13S R7W S15) – 24.V.2000, through rotten *Eurhynchium oreganum* covered log or soil duff in 60yo *Pseudotsuga menziesii* with *Acer circinatum, Gaultheria shallon*, RLExeter *Ex200-008,009,010* (PNW); Green Peak, BLM Unit, Mid Rd 14-6-17.1 (123.44°W,44.37°N) – at 400m in woody duff & abundant *Eurhynchium oreganum* in thinned 65 yo *Pseudotsuga menziesii* with no understory, *LLN1990421-04 with* RLExeter (PNW); Hull-Oakes Sawmill Mainline Rd/101-D spur (123.42°W, 44.35°N) – 200m, in rocky clay covered with *Eurhynchium oreganum* in 50yo *Pseudotsuga menziesii* with *Arbutus menziesii* Pursh, *Corylus cornuta, Polystichum munitum, Synthiris reniformis, LLN1990413-01* with SARedhead (PNW), *LLN2000426-01* with RLExeter (PNW). **Lane Co.** SiuslawNF: 1.7mi from Indian Crk Rd jct on FSR 2127 (T17S, R9W, S2), Indian Crk CVS plot # 1092048 – 7.XI.2000, in soil, *Cazares1380 & 1382* by BPerrone (OSC), *Cazares1381* by RRipley (OSC); 1.7 miles from 37 Rd Jct on FSR 3230 (T15S R10W S24), Old 37 CVS plot # 2097048 – 8.XI.2000, in soil, *Cazares1390* by DCDickenson (OSC); 2 mi from Buck Crk Bridge on FSR37 (T15S R9W S11), 37 Rd CVS plot # 1098048 – 21.XI.2000, in soil, *Cazares1484 & 1485* by DCDickenson (OSC). 15 mi N Florence (124.099°W, 43.983°N) – 20.XI.1980 *GWright21-3* (MICH, as *P. radicata*). **Lincoln Co.** Drift Creek – 6.XI.1995, *LLN1951106-01* by NSWeber (WTU). SiuslawNF FSRd 5860, 0.2mi across Canal Crk (T14S R10W S8), CVS plot # 1102044 – 1.XI.2000, in soil, *Cazares 1347 & Cazares 1362* by DCDickenson (OSC).

COMMENTS – I first discovered *Phaeocollybia phaeogaleroides* during an examination of a collection labeled as *P. radicata* (Murrill) Singer in the University of Michigan fungal herbarium. Many of its diagnostic characters – small fragile aspect, solitary to scattered habit, occurrence in moss in coniferous habitats, overall tan coloration, and large ellipsoidal non-dextrinoid basidiospores – recall the genus *Phaeogalera* for which the species is named. Subsequent collections of fresh material revealed that basidiomes exhibit a much deeper color *in situ* and may also fruit in loosely gregarious clusters.

In the field *P. phaeogaleroides* might be mistaken for a very small, fragile *P. attenuata* (Smith) Singer or *P. pleurocystidiata* Norvell & Redhead. Representatives of both those species, however, are typically far more robust, possess heavily ornamented, prominently beaked basidiospores, and lack clamp connections. *P. pleurocystidiata* is further differentiated by the possession of secretory, thick-walled, tibiiform cheilocystidia and pleurocystidia. The clamp connections of *P. phaeogaleroides* are among the most conspicuous of any *Phaeocollybia* studied by this author, and it is the only species tested thus far with fresh gills that do not fluoresce when viewed under UV. Other diagnostic characters include the unusually large tibiiform diverticula and narrow, thin-walled, strangulated and/or subcapitate cheilocystidia. In the two Canadian specimens (*ROuterbridge109 & 298*), cystidia-like cells appeared to develop wherever the hymenium was damaged, in itself an unusual phenomenon in the genus. Under low power, basidiospores appear almost smooth, additionally seeming to possess apical pores characterizing the genus *Phaeogalera*. Under oil immersion, however, the faintly verruculose-roughened ornamentation is visible and the 'pores' are more properly seen as small callus deposits forming rounded to slightly pointed refractive apices. Large ellipsoidal punctate-roughened basidiospores, rarely found in the genus, also characterize *P. christinae* (Fries) Heim. While *P. christinae* also produces small fragile basidiomes with filamentous/subcapitate thin-walled cheilocystidia, it lacks clamp connections and possesses a more brightly colored pileus, slightly shorter, narrower, more highly ornamented basidiospores, and smaller tibiiform diverticula.

P. phaeogaleroides is one of very few western Phaeocollybias known to fruit in both autumn and spring; both vernal collections were made in areas where the vernal *P. pleurocystidiata* was quite abundant. No molecular research has yet been performed on *P. phaeogaleroides*.

Phaeocollybia rifflipes Norvell *sp. nov.* FIGURES 3-5

Pileus (10) 20-40 (55) mm latus, e conico-convexo cum papilla acuta conico-campanulatus, umbonatus, viscidus vel glutinosus, glaber, e fulvo olivaceo-brunneus; caro in disco crassa, super lamellas tenue, pallida; odor lenis vel leviter florali; sapor lenis vel subamarus; lamellae violaceae vel avellaneae, brunnescentes e sporis; stipes 4-9 (12) mm versus apicem, 30-50 mm longus supra terram usque ad 165 mm longus cum pseudorhiza attenuata, versus apicem squamulosus, e farcto cavus, versus apicem avellaneus, versus subapicem aurantiascens. Sporae 7-7.5 x 4-4.5 μm, limoniformes, verruculosae vel verrucosae cum rostro acuto, glabro et cum apiculo excentrico glabro; ixocutis cum suprapelle crassa, gelatinosa, hyalina et subpelle cum pigmento intraparietali; cheilocystidia angusto-clavata vel late clavata (5-7 μm usque ad 10 μm lata), gelatinosa, leptoderma, hyalina. Fibulae desunt in texturis omnibus. Typus *ad terram in Pinacearum mixtarum, 20 October, 1993, L. L. Norvell cum S. A. Redhead et G. L. Barron, Barlow Pass, Baker-Snoqualmie National Forest, Snohomish County, Washington, USA (Holotypus LLN1931020-01 WTU; Isotypus, DAOM).*

Etymology: from RFLP (Random Fragment Length Polymorphism), the molecular analytical technique that first implied the existence of a previously undiagnosed *Phaeocollybia.*

BRIEF SUMMARY – Basidiomes deeply rooting, scattered to gregarious, small to medium sized; pilei convex-campanulate, glutinous, tawny to dark brown; young lamellae pale violet gray to dull pinkish brown; stipes slender, shiny, drab, fibrillose-stuffed to hollow; pseudorhizae fleshy, vertical-monopodial; basidiospores relatively small (~7 x 4.5 μm), limoniform with an apical beak, verruculose; cheilocystidia thin-walled, clavate; pileipellis bilaminate with a thick gelatinous colorless suprapellis overlying an orange subpellis; clamp connections absent. All tissues negative in syringaldazine. Dried pileus

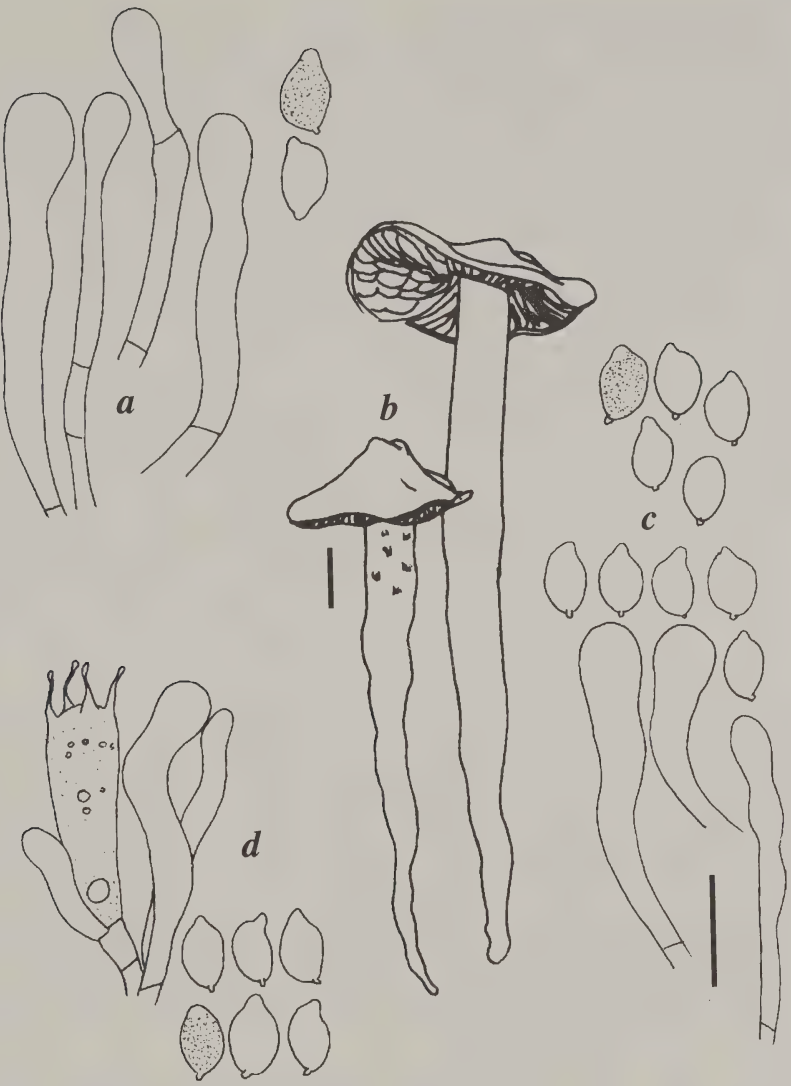

FIGURE 3. *Phaeocollybia rifflipes.* Microscale (for FIGS 3A, 3C, 3D) = 10 μm; Macroscale (FIG 3A) = 1 cm. FIG 3A. Thin-walled clavate cheilocystidia and limoniform basidiospores from a collection from Larch Mountain, Mt Hood National Forest, Oregon (LLN1921104-05, WTU). FIG 3B. Excavated basidiomes displaying vertical-monopodial pseudorhizae typical of most *Phaeocollybia* species. (Left adapted from LLN1931020-01, Holotype – WTU, from Barlow Pass, Washington; Right adapted from LLN1921023-08, WTU, Olympic National Park, Washington.) FIG 3C. Limoniform beaked basidiospores and thin-walled cheilocystidia found in Holotype. FIG 3D. Basidia, hyphidia (paracystidia), basidioles and basidiospores. LLN1921023-08 (WTU).

carbonized blackish brown.

Expanded Technical Description – Pileus (10) 20-40 (55) mm, initially conic-convex with acute papillate umbo, soon conic-campanulate with low broad umbo and incurved to downturned margin with long-inrolled edge; surface glabrous, viscid to heavily glutinous; color when young tawny to dark orange-brown overall or with darker disc *(Verona Brown, Russet, Hazel)*, tawny to brown margin *(Hazel, Tawny, Chestnut /Sayal /Verona Brown)*, and red-/yellow-brown edge *(Buffy /Army /Chestnut /Cinnamon Brown)*, in age more or less uniformly dark brown *(Olive Brown)* with a dark green-brown *(Dark Olive)* edge; when dried carbonized black-brown, noticeably striate. **Context** relatively thick (1-4 mm) at the disc, thinning abruptly over the lamellae; color pallid or buff when young, in age or after exposure brown or drab; often consumed by insects. **Odor** not distinctive to slightly floral. **Taste** mild or (occasionally) faintly bitter. **Lamellae** free to narrowly attached; subcrowded (L+ll/cm –15 @ edge, 12 @ midpoint) with 3-5 tiers of lamellulae irregularly interspersed; ventricose, moderately broad (3-5 mm), thin; edges even at first, soon uneven to eroded; color pale violet or bluish gray when young *(Dark Vinaceous Gray, Pale Vinaceous Drab)*, dulling as maturing *((Light Brownish) Drab, Avellaneous, Wood Brown, Vinaceous Buff)*, in age obscured by dark brown *(Verona Brown)* spores. **Primordial sheath remnants** when present evident as (usually) scattered, short, fibrillose patches on stipe apex and/or (occasionally) fibrils overlying lamellae. **Stipe** central to slightly eccentric, terete or compressed, fleshy, aerial length (when pileus fully expanded) generally 30-50 mm, combined length including pseudorhiza up to 165 mm; apex 4-9 (12) mm diam, either widening slightly to ground level or tapering evenly to pseudorhizal origin; surface smooth and shiny beneath relatively dense fibrillose patches; stuffed, with 1.5-2 mm thick cartilaginous cortex surrounding firm (packed when young) to spongy (in age) pallid context, context easily compressed when water-soaked and in age often insect-infested; color generally with drab to smoky brown tones at apex (*Deep Quaker /Cinnamon Drab, Avellaneous, Benzo /Army /Natal /Pecan /Wood Brown)*, increasingly darkening in hue towards ground level *(Dusky Drab, Fawn Color, Army /Liver /Natal /Rood's /Sayal Brown, Tawny Olive)*. **Pseudorhiza** vertical monopodial, fleshy-cartilaginous, with dark red-brown *(Cameo /Hay's /Liver /Mikado /Van Dyke /Verona Brown)* upper portion arising from narrow, curled/nippled, brownish drab origin.

Spore print color cinnamon-brown *([7.5YR 6-7/4] = (Light) Pinkish Cinnamon)*.

Basidiospores 7 x 4.5 ± 0.0 x 0.3 μm (overall range 7-7.5 x 4-4.5 μm), ovate with small apiculus projecting in face view, strongly limoniform with distinct small apiculus and low to moderate beak in profile; verruculose to verrucose, suprahilar disc an area of lowered ornamentation visible rarely and with difficulty in oil immersion; pale to medium pale amber in KOH, pale straw in H_2O.

Cheilocystidia abundant and crowded, emanating from the lamellar trama to form a dense gelatinous layer, variable in length (15-45 μm), narrowly to broadly clavate, apices usually 5-7 μm diam above long, 3-4 μm diam pedicels, these elements often intermixed with narrower (2-3 μm), cylindrical and/or wider (up to 10 μm), clavate elements, thin-walled; hyaline or (in age) filled with oily brownish contents. **Paracystidia** occasional within basidial clusters, filiform, 2 μm wide. **Basidia** (2-) 4-spored, 26-36 x 6-7.5 μm, clavate, hyaline (brownish in older specimens). **Pileipellis** a bilaminate ixocutis; the suprapellis extensive (150-350 μm thick) and colorless, hyphae long, branched, narrow (1-3 μm), straight or occasionally curling, hyaline, and gelatinized with the uppermost hyphae uplifted from a radially aligned base within a gelatinous matrix; the subpellis brilliant amber-orange, hyphae thin-walled, inflated (to 5-8-10 μm from 3-5 μm diam septa), with intraparietal pigments most noticeable at the septa. **All tramal tissues** gelatinized, colorless; in the *pseudorhiza* mildly sarcodimitic, with wider, thick-walled, cylindrical, vessel hyphae intermixed with less conspicuous, thin-walled, branched, flexuous hyphae; from *stipe* to *pileus* dual hyphal system progressively less noticeable, with flexuous hyphae increasing in number as vessel hyphae become more narrow, thin-walled and distorted; in the *lamellae* subparallel, the central region of 3-5 μm wide hyphae flanked by a compact subhymenium. **Tibiiform diverticula** abundant on remnants of the pellicular sheath on pseudorhizal and stipitipellis, 5-12 (20) x 2 x 0.5 μm with/without 1-1.5 μm wide capitellum, usually surrounded by an apical secretory droplet; hyaline. **Clamp connections** absent in all tissues.

Macrochemical reactions: *Syringaldazine* negative (in *LLN1921031-02* lamellae slightly pink). *KOH* turning dull or slightly brown. *FeSO4* dull green-brown. **Fluorescence:** *Lamellae* intense yellow-white when young, intensity dulling as covered by spores; *Context* dull orange (stipe). **RFLP profile:** ITS region of 4 isolates including type = 730 bps. Unique among tested Phaeocollybias in Hinf1 (400-190-140); Pal1 (475-170-85) and Sal1 (535-190) also diagnostic. Also cut in EcoR1 and Nde2; uncut in Pvu2, Rsa1, and Xho1.

Ecology, range, distribution, phenology: solitary to scattered (rarely gregarious) in old-growth coniferous montane (650-1350 m elev) forests (*Tsuga heterophylla* with *Abies* spp. *Picea sitchensis*, *Pseudotsuga menziesii* and *Sequoia sempervirens* (D. Don) Endl. also present). Uncommon to rare, known from 14 collections made in coastal and inland Washington, Oregon and northern California. Mid/late autumn (October-December).

SPECIMENS EXAMINED: UNITED STATES. California. **Mendocino Co.** Jackson SF near Mendocino (123.792°W, 39.308°N) – solitary in humus in mixed woods, 29.XII.1960, *HDThiers8634 pp* (SFSU, as *P. fallax);* 14.XI.1967 *HDThiers21536* (SFSU, as *P. fallax).* Oregon. **Clackamas Co.** Estacada , Horner Rd (122.285°W, 45.225°N) – 17.X.1992 *JRoger92.10.17-1* (WTU). **Linn Co.** S McCully BLM UnitA 9S 2E 31 – under *Tsuga heterophylla* and *Pseudotsuga menziesii*, 15.XI.1999, *RLExeter199-M* by MLowery (PNW). **Multnomah Co.** Larch Mtn summit, Mt HoodNF (122.089°W, 45.531°N) – in late successional (120 yo) *Abies procera*, *Tsuga heterophylla* (no understory), *LLN1921104-02*$_{riu10}$, *-03*$_{riu9}$, *-05*$_{riu8}$ with GTNorvell, SARedhead, PWTrimm (PNW, WTU); *LLN1931024-05* with

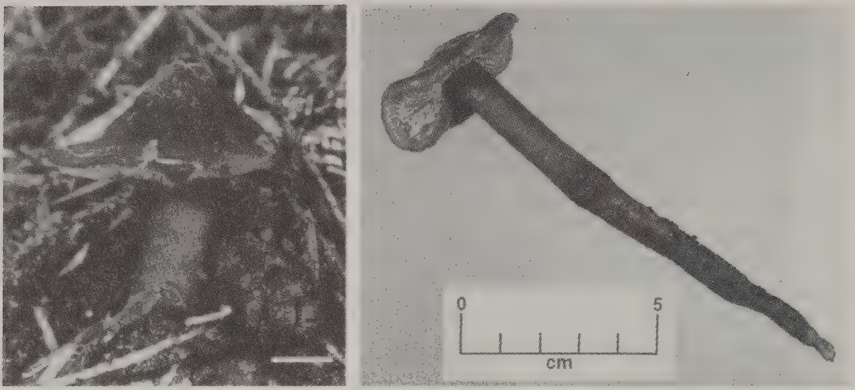

Figure 4. *Phaeocollybia rifflipes*. Left. Holotype (LLN1931020-01, WTU) *in situ,* Barlow Pass, Snohomish County, Washington. Note appressed fibrillose patches on stipe apex. Scale = 1 cm. Right. Young basidiome from Olympic National Park, Washington. LLN1921023-08 (WTU).

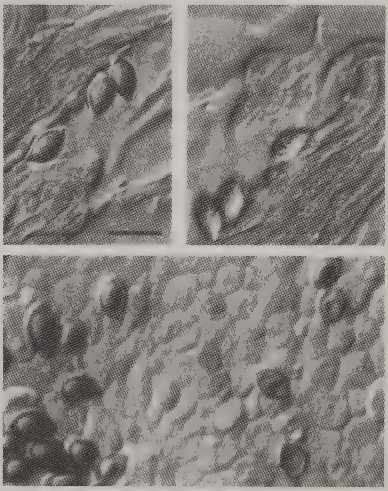

Figure 5. Basidiospores produced by western North American representatives of the *Phaeocollybia festiva* complex. Scale = 10 microns. Top. *Phaeocollybia lilacifolia* (Holotype -- AHSmith39976, MICH 11625). Photo at right reveals generically characteristic tibiiform diverticula found on vestiges of pellicular sheath on apical stipitipellis. Bottom. Comparison between larger, darker basidiospores from *Phaeocollybia fallax* (left, LLN1951018-23, WTU) and smaller, paler basidiospores from *Phaeocollybia rifflipes* (right, Holotype -- LLN1931020-01, WTU).

GTNorvell (PNW); Larch Mtn Road, 3 mi below summit (122.094°W, 45.540°N) – in 2nd growth, dense mid-successional *Tsuga, Picea, Abies, LLN1921111-02,-05,-06* with OLNorvell, PWTrimm (PNW, WTU). **Washington. Clallam Co.** Olympic NP. Rugged Ridge Trail (124.172°W, 47.932°N) – old growth *Tsuga, Abies, Pseudotsuga, LLN1921023-08* (WTU); Sol Duc, Upper Valley (123.8632°W,47.9623°N) – in ancient *Picea, Tsuga, Abies, LLN1921031-02* by GLBarron (DAOM). **Snohomish Co.** Mt Baker-Snoqualmie NF, Barlow Pass (121.437°W, 48.034°N) – in ancient (>450 yo) *Abies, Tsuga, Pseudotsuga* forest, *LLN1931020-01*$_{rif3}$ with GLBarron, SARedhead (WTU – HOLOTYPE; DAOM – isotype).

Comments – *Phaeocollybia rifflipes*, which shares morphological similarities with *P. fallax* AHSmith and *P lilacifolia* AHSmith, was first recognized as a distinct species during RFLP analyses of 160 *Phaeocollybia* collections. The ITS region amplified from 17 specimens provisionally identified as *P. fallax* or *P. lilacifolia* produced five different enzyme profiles. One “fallax” isolate from Washington produced such different banding patterns that its ITS region (then coded *fal3*, later recoded to *rif3)* was originally thought to have been an amplified contaminant. When its banding patterns were later compared to all other *Phaeocollybia* isolates, however, three 'unknowns' from Oregon (*unk8, unk 9, & unk10,* later recoded to *riu8, riu9, & riu10* respectively) were found to possess the identical profile. Subsequent comparison of morphological characters revealed that all four collections represented the same undescribed species. *Phaeocollybia rifflipes,* named here for the RFLP-facilitated discovery of a cryptic species, differs from *P. lilacifolia* in its smaller size, more brightly colored (tawny instead of dark black brown) young pileus, narrower, duller lamellae, lack of disagreeable odor, smaller basidiospores, filiform paracystidia, and brilliant orange subpellis. *Phaeocollybia fallax* is differentiated by an olive green young pileus, intense violet lamellae, frequently hollow stipes, larger basidiospores, and gel-secreting, subcapitate cheilocystidia.

The *Phaeocollybia festiva* “complex”

Phaeocollybia rifflipes is a member of a difficult complex of agarics centered around *P. festiva*, originally described from Sweden (Fries 1838). Species in this complex – *P. festiva* and the North American endemics *P. fallax, P. lilacifolia,* and *P. rifflipes* -- produce small to moderately sized, relatively fragile, relatively odorless/tasteless basidiomes with conic-campanulate glutinous pilei, medium to large (7-9 (10) x 4-5 μm), roughened, limoniform basidiospores, thin-walled +/- clavate cheilocystidia emanating from the lamellar trama, and highly gelatinized tissues lacking clamp connections (*NB:* Smith's listing of clamp connections for *P. fallax* in his 1975 field guide was a *lapsus calamis).*

Phaeocollybia festiva (with *P. christinae* and *P. lugubris* (Fries) Heim) is one of the three most frequently discussed Phaeocollybias in the literature. Fries, who in his Epicrisis (1838) first treated the species within the tribe *Naucoria* in *Agaricus,* described *P. festiva* as having a green-brown glutinous pileus that dried to a dirty gold (isabelline), pale olive colored lamellae, an apically compressed (neither equal nor ventricose) stipe often covered with dark fibrils, and a raphanoid odor. Later authors expanded the original description to accommodate observed variability. Thus Kühner & Romagnesi (1953) noted that while the pileus was generally olive to olive brown, it could also be chestnut or red-brown ('*aussi bai ou roux*'). Moser (1983, 1995 pers. com.; *cf.* also Moser & Jülich 1994), Gulden (1983), and Jacobsson & Stridvall (1983) all remark on the violet lamellae found in occasional specimens, and Gulden (1983, 1992) mentions the drab to violet gray coloration found on some stipe apices (otherwise characterized as being olive-colored). A wide range of spore lengths (from 7-10 μm) is listed for the species, and examinations of *Gulden771/81* (O) from Bredehaugen, Norway show that this range can be found within a single specimen. Descriptions of the spore ornamentation range from subdued and marbled (Kühner & Romagnesi 1953; Reid 1972) through minutely warty (Horak 1977) to strongly or heavily ornamented (Laber 1982; Gulden 1983; Jacobsson & Stridvall 1983). Examination of *Gulden771/81* reveals marbled spores with very low indistinct warts stopping well below the apical beak. Also observed in the same collection is a suprahilar disc of lowered ornamentation (reported as "plages" for the species by Bon 1992 and Watling & Gregory 1993, which were noted as lacking by Horak 1977). The shape is variously described as being ovoid (Horak 1977) to limoniform.

Field identification of species within the complex is often complicated by mutable pigments found in the pilei and lamellae. Within a single species, pileus colors can be green, brown, orange or some shade in-between, while the base color of the young lamellae -- yellowish buff, tan, pink, drab, violet -- is soon obscured by brown spores. Also within a given species, stipes may vary from firmly stuffed, to stuffed with fibrillose pith, to hollow.

Differentiation of species within the complex using a rather undistinguished assemblage of microscopical characters is problematical as well. In some species (notably *P. festiva),* basidiospore size can be highly variable, while in others the size range appears to be more restricted. Cheilocystidial morphology can be filamentous, cylindrical, narrowly or broadly clavate, or subcapitate subglobose pedicellate. The cheilocystidia are generally quite abundant and crowded, and often there is a mix of all forms within a single specimen.

Comparisons of North American material earlier identified as *P. festiva* as well as recent collections made during the current study to the Norwegian *Gulden771/81* suggest that *P. festiva* does not occur in western North America. Smith (1937) originally reported *Naucoria festiva* from the Pacific Northwest but later (Smith 1957b) reassigned his collections to *P. fallax*. Although Smith et al. (1979) reintroduced *P. festiva* in their keys to North American gilled mushrooms, there is no published documentation or correctly identified material of that species (at MICH or elsewhere) from North America. It would seem that inclusion of *P. festiva* in the 1979 key is erroneous and that the species should be considered strictly extralimital.

In North America, Phaeocollybias with olive-green pilei and intense bluish violet lamellae are instantly identifiable as *P. fallax*, originally also characterized by a sharply conic-umbonate glutinous pileus, dull drab to greenish stipe apex above a hollow polished orange stipe, and a moderately small stature and fragile aspect. The violet lamellae, helpful in separating *P. fallax* in the field from two other green-capped species – *P. olivacea* AHSmith and *P. pseudofestiva* AHSmith – rapidly dull and darken as they mature. The olive-green cuticle, which usually darkens with age or exposure, can also be obscured in young specimens by a bright orange-brown to dark brown glutin, thereby causing confusion with the tawny capped *P. rifflipes* and dark brown capped *P. lilacifolia*. Character variations in *P. fallax* noted by this author should be mentioned here. While Smith (1957b) describes *P. fallax* stipes as "tubular-hollow", stipes stuffed with relatively firm (*i.e.* not fibrillose) context have been observed in several specimens otherwise clearly identifiable as *P. fallax*. Likewise, while most specimens sampled by this author did taste "mild", numerous older specimens, (including all November 1992 collections from California's Humboldt Redwoods State Park) were found to have pilei with bitter-tasting cuticles and/or glutin. Additionally, although some "fallax" collections were found to possess the "basidia-like" cheilocystidia originally described and illustrated by Smith, a much greater proportion (including some type specimens) were found to be dominated by distinctly subcapitate cheilocystidia, which Smith considered more characteristic of *P. lilacifolia*. It would appear that a more reliable diagnostic character is the fact that in KOH, "fallax" cheilocystidia characteristically exude a clear heavy gel that eventually spreads out into a dense gelatinous matrix; evidence of this matrix can also be seen in squash mounts in which the abundant cheilocystidia stick together in a dense agglutinated "barrier", particularly in older or poorly preserved specimens.

With additional molecular sampling, some of the observed variability, such as basidiospore length differences, may be shown to be associated with other cryptospecies hiding under the name of *P. fallax*. Of the 122 "fallax" collections examined in the current study, most were characterized by basidiospores measuring ~9 x 5 μm; 26 collections, however, contained specimens with basidiospores measuring ~8 x 5 μm. Because these differing spore lengths are not tied to other morphological, anatomical, or molecular differences, the small-spored collections are retained in *P. fallax*. More problematical are collections from Oregon's Wildcat Mountain near Mt. Hood (in particular *LLN1941028-04*,-05*,-08*,-17** [WTU, PNW] and *LLN1951018-12*,-23** [WTU, PNW]). In the field, these were all clearly identifiable as *P. fallax*, despite having less intensely violet lamellae and lacking striations and incurved edges on the pileus. In view of the presence of secretory cheilocystidia and green pigments and the absence of supporting molecular data, these collections have been retained in *P. fallax*, despite sharing a similar basidiospore morphology with *P. rifflipes*.

Phaeocollyba lilacifolia, like *P. rifflipes*, lacks green pigments. This largest representative of the *P. festiva* complex is distinguished from *P. rifflipes* by its more robust stature, darker pileus, larger basidiospores, and narrower cheilocystidia and from *P. fallax* by its dark brown slightly broader pileus, larger size, narrower cheilocystidia, and slightly disagreeable odor. Although Horak (1973) initially illustrated clear differences between basidiospore size, ornamentation, and extent of "plage" in his drawings of *P. fallax* and *P. lilacifolia*, he eventually placed the latter species in synonymy with *P. fallax* (Horak 1977). At that time Horak did not discuss either basidiospore or pigmentation differences, although he later addressed the mutability of both green and lilac pigments in *Pyrrhoglossum* and *Phaeocollybia*, genera which he considered to be closely allied (Horak 1989). As noted above, recent collections of numerous "fallax" basidiomes with both green and brown colors on their pilei underscore the difficulty of relying solely on pileus pigmentation for species differentiation in this difficult group.

At this date, molecular data analyses are still too fragmentary and inconclusive to test the two species hypotheses. However, given the more robust stature of *P. lilacifolia* noted by Smith (1957ab), the different average spore lengths observed in the types [8 μm and 9 μm respectively for *AHSmith39976, MICH 11625** (*P. lilacifolia),* and AHSmith79252*, MICH (*P. fallax*)], and pigmentation differences [also cited by Bandala (1994) as a reason for rejecting Horak's synonymy], *P. fallax* and *P. lilacifolia* should be retained independent taxa, at least for the time being.

A final nomenclatural note: It should be noted that in his monograph, Smith (1957b) discussed *P. lilacifolia,* a species he had previously described in another paper published the same year (Smith 1957a), before *P. fallax*. From this, an argument can be made that should the two species be considered synonymous, the name *P. lilacifolia* has priority.

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PRELIMINARY CHECKLIST OF AGARICALES FROM CROATIA. I. FAMILIES PLEUROTACEAE AND TRICHOLOMATACEAE.

ZDENKO TKALČEC & ARMIN MEŠIĆ

Laboratory of Biocoenotics, Department of Molecular Genetics
Ruđer Bošković Institute
Bijenička cesta 54, 10000 Zagreb, Croatia
E-mail: zdenko.tkalcec@zg.tel.hr
E-mail: armin.mesic@zg.hinet.hr

ABSTRACT

The first part of the preliminary checklist of Agaricales from Croatia is given. It comprises the families Pleurotaceae and Tricholomataceae. 252 species (three of them in a broad sense) belonging to 48 genera are presented. Three genera and 35 species are reported for the first time from Croatia. For each species, the published and unpublished sources of data are given, as well as the collections in which the material is deposited.

Key words: Basidiomycotina, biodiversity, mycoflora, bibliography.

INTRODUCTION

The fungi of Croatia are poorly known. Some parts of Croatia have never been mycologically explored. The Agaricales are no exception as few mycologists have researched the order. The first data on this taxonomic group were published by Stjepan Schulzer (1857). He was the only Croatian mycologist in the second half of the 19 century. It was not until the second half of the 20 century that more intensive research was carried out. Significant contributions to the research on the Agaricales during that period were made by Milica Tortić, Ivan Focht, Neven Matočec and the authors of this paper. Although it has been a century and a half since the beginning of mycological research in Croatia, no survey of species of Agaricales has been made until now. As the first step to a recently started comprehensive research of this taxonomic group in Croatia, we are preparing a checklist of species of the order Agaricales from Croatia including all published and most unpublished sources of data known to us. This checklist should be considered only preliminary since only some data have been revised and that comprehensive research of this taxonomic group in Croatia has just begun. The checklist will be divided into five articles of which this is the first. The proposed articles will treat the families in the following order: I. - Pleurotaceae, Tricholomataceae; II. - Agaricaceae, Amanitaceae, Cortinariaceae, Hygrophoraceae; III. - Boletaceae, Gomphidiaceae, Paxillaceae; IV. - Bolbitiaceae, Coprinaceae, Entolomataceae, Pluteaceae; V. - Crepidotaceae, Russulaceae, Strophariaceae.

Geographically, Croatia connects southern and central Europe. It is situated between 42°22' and 46°33' northern latitude, and between 13°29' and 19°27' eastern longitude. The land area of Croatia is 56,610 km^2. The altitude varies from 0 to 1,831 m. Croatia consists of three main geographic entities: the Pannonian lowland zone, the Karst mountainous zone of the Dinarides and the Mediterranean zone of the coast and islands of the Adriatic Sea. The main types of climate are moderate continental, mountainous and mediterranean. The average annual temperature ranges from 3.0 to 16.5 °C. The average annual rainfall ranges from 260 to 3,700 mm. The area of Croatia covered by forest is 37% of its land area. In the Pannonian lowland zone the dominant trees are *Quercus robur*, *Q. petraea* and *Carpinus betulus*. In the Karst mountainous zone the dominant trees are *Fagus sylvatica*, *Abies alba* and *Picea abies*. In the Mediterranean zone the dominant trees are *Quercus ilex*, *Q. pubescens*, *Carpinus orientalis*, *Ostrya carpinifolia*, *Pinus halepensis* and *P. nigra*.

MATERIAL, METHODS AND PRESENTATION

This checklist includes, except for a few cases, all the published records of species, subspecies and varieties of the order Agaricales (sensu lato) from Croatia, known to us. Records from daily and weekly newspapers, records obviously erroneously identified, and records from Hafner (1997) due to false data, have been excluded. This checklist also includes, except for a few cases, all the unpublished records known and available to us. Two manuscripts by Stjepan Schulzer have not been included (one is kept at the Library of the Hungarian Academy of Sciences in Budapest, and the other at the National and University Library in Zagreb), as well as notes by Ivan Focht, because it is not possible to interpret their data in a satisfactory way without thorough revision. We have also excluded the unpublished records whose identification the original author doubted. The checklist includes data published or collected until 1 January 2000. The material known to us is deposited in the following herbaria and fungaria.

BEO - Herbarium, Botany Department, Natural History Museum of Serbia, Beograd, Yugoslavia.
BP - Herbarium, Botanical Department, Hungarian Natural History Museum, Budapest, Hungary.
BRA - Herbarium, Botany Department, Natural History Museum, Slovak National Museum, Bratislava, Slovakia.
BRNM - Herbarium, Department of Botany, Moravian Museum, Brno, Czech Republic.
Candusso - Private fungarium of Massimo Candusso, Alassio, Italy.
CNF - Croatian National Fungarium, Croatian Mycological Society, Zagreb, Croatia.
H - Herbarium, Botanical Museum, University of Helsinki, Helsinki, Finland.
Hilber - Private fungarium of Oswald Hilber, Tegernheim b. Regensburg, Germany.
L - Rijksherbarium, Leiden, the Netherlands.
Mrvoš - Private fungarium of Dušan Mrvoš, Zagreb, Croatia.
POZM - Herbarium, Department of Plant Ecology and Environment Protection, Adam Mickiewicz University, Poznań, Poland.
PRM - Herbarium, Mycological Department, National Museum in Prague, Praha, Czech Republic.

Along with each presented species we specify the published and unpublished sources of records for Croatia, and the collections in which the collected material is deposited. In this way we give a more or less complete survey of the published sources of data, as well as a good survey of the unpublished sources of data on the species of the order Agaricales in Croatia. We also specify synonyms and misapplied names which the authors of records of taxa have used, as well as those used in modern taxonomic literature. We have tried to interpret all records on the basis of taxa names and dates of recording in the sense of modern taxonomy. The older the record, the greater the need for revision. So far we have revised only a part of the revisable records. We have revised all our entries in this checklist, as well as a smaller number of records by other authors indicated as such in the text. Species and varieties revised by us, as well as species and varieties recorded for Croatia by authors of taxonomic literature which we have used for the interpretation of records are marked with a black dot. At the end of the data specified for such species we cite the literature (in brackets) on the basis of which we have revised or interpreted the records. The name of each genus is followed by the literature (given in brackets) used for the interpretation, nomenclature and synonyms of records in the genus. At the end of genus we have included those species for which only a wide locality is quoted, but on which basis one may conclude that the species was most probably found in Croatia. Schulzer (1867) corrects numerous mistakes from the paper by Schulzer &

al. (1866), so we give such quotes as "Schulzer *& al.* (1866) + Schulzer (1867)". We have cited abbreviations of authors of taxa according to Kirk & Ansell (1992) and abbreviations of journals in chapter "Literature cited" according to Bridson & Smith (1991).

The chapter "Excluded records" comprises: (a) records of species and infraspecific taxa we were unable to find in modern taxonomic literature, (b) records we could not interpret in the sense of modern classification, (c) records which are a nomen nudum, and (d) records which have been incorrectly recorded for Croatia or have been recorded for the territory which does not now belong to Croatia. Genus, subgenus or section listed by the original author is specified in square brackets. When we could not check whether the author of the record had given the correct author citation, we have given it herein according to that author.

In this paper we present 252 species (three of them in a broad sense) belonging to 48 genera found on the territory of Croatia, of which we have revised 125 species. Out of the overall number 13 species belong to the family Pleurotaceae and 239 to the family Tricholomataceae. Three genera and 35 species are reported for the first time from Croatia.

Marks and abbreviations:

* - taxon reported for the first time from Croatia in this paper;
• - at least part of records of taxon revised;
(1) - number in brackets indicates synonym or misapplied name under which the author of the record has quoted taxon;
( ) - empty brackets indicate that the author of the record has also quoted the taxon under the name we use;
? - (a) question mark instead of an author of combination means that we could not find the author in the literature available to us; (b) question mark following the source of a published record or abbreviation of a collection means that the author himself doubted his original identification;
= **?** - taxon not found in modern taxonomic literature;
Exs. - collections in which the dried material (exsiccatum) is deposited;
HR? - taxon most probably found in the territory of Croatia (locality not precisely quoted);
Incl. - including;
Lit. - literature;
Misappl. - misapplied name;
Ref. - references (sources of records of taxon);
rev. - revised (when we have revised records of other authors);
unp. - unpublished data.

SURVEY OF TAXA

Familia **Pleurotaceae** Overeem ex Kühner et Romagn.

Lentinus Fr. : Fr.
= *Panus* Fr.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1990, Bollmann *& al.* 1996, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kotlaba & Pouzar 1996, Kreisel 1987, Pegler 1983, Pilát 1935, Pilát 1946, Singer 1986, Watling & Gregory 1989)

Lentinus adhaerens (Alb. et Schwein. : Fr.) Fr.
= *Lentinus pulverulentus* (Scop.) Fr. (1)
Ref.: Škorić 1928 (1), Tortić 1973 ( )(1), Tortić 1989 b, Tortić 1993, unp. Tortić
Exs.: CNF

•***Lentinus conchatus*** (Bull. : Fr.) J. Schröt.
= *Panus conchatus* (Bull. : Fr.) Fr. (1)
= *Lentinus bresadolae* Schulzer (nom. illeg.) (2)
= *Lentinus divisus* Schulzer (3)
= *Agaricus pulvinatus* Pers. : Fr. (4)
= *Lentinus torulosus* (Pers. : Fr.) Lloyd
= *Panus torulosus* (Pers. : Fr.) Fr. (5)
Ref.: Saccardo 1887 (2), Schulzer 1879 (3), Schulzer 1885 (2), Schulzer *& al.* 1866 (5), Tortić 1964 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1993 (1), Vouk & Pevalek 1916 (4), unp. Matočec (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Gregory 1989)

•***Lentinus degener*** Kalchbr.
= *Lentinus leontopodius* Schulzer (1)
Misappl.: *Lentinus cyathiformis* (Schaeff.) Bres. sensu auct. non Schaeff. (2)
(sensu Schaeff. = *Pleurotus pulmonarius* (Fr. : Fr.) Quél. - Kotlaba & Pouzar 1996)
Ref.: Kalchbrenner & Schulzer 1873-1877 (1), Pilát 1946 (2), Tortić 1968 b (2), unp. Tkalčec & Mešić, unp. Tortić (2), Fries 1874 HR? (1), Saccardo 1887 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Moser 1983, Pegler 1983)

Lentinus lepideus (Fr. : Fr.) Fr.
= *Lentinus queletii* Schulzer (1)
= *Lentinus squamosus* (Schaeff. →) Quél. (2)

Ref.: Focht 1974, Schulzer 1885 (1), Tortić 1989 b, Vouk & Pevalek 1916 (2), unp. Tortić, Saccardo 1887 HR? (1)
Exs.: CNF

•***Lentinus strigosus*** (Schwein. : Fr.) Fr.
= *Lentinus lecomtei* Fr. : Fr.
= *Panus lecomtei* (Fr. : Fr.) Corner (1)
= *Lentinus rudis* (Fr.) Henn. (2)
= *Panus rudis* Fr. (3)
= *Pleurotus rudis* (Fr.) Pilát (4)
= *Panus sainsonii* (Lév.) Heufl. (5)
Ref.: Moesz 1938 (3), Picbauer 1928 (3), Pilát 1925 (3), Pilát 1935 (4), Schulzer 1882 a (5), Tortić 1962 (3), Tortić 1964 (3), Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1989 b (3), Tortić 1993 (1), Vouk & Pevalek 1915 (2), unp. Lisiewska (3), unp. Matočec (1), unp. Tkalčec & Mešić, unp. Tortić (3)
Exs.: CNF, POZM (3)
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•***Lentinus tigrinus*** (Bull. : Fr.) Fr.
= *Panus tigrinus* (Bull. : Fr.) Singer (1)
Ref.: Božac 1982 (1), Jelić & Tortić 1973 (1), Schulzer 1882 a, Schulzer *& al.* 1866, Škorić 1938, Tortić 1964 (1), Tortić 1989 b (1), unp. Matočec (1), unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Gregory 1989)

Phyllotopsis (J.-E. Gilbert et Donk) ex Singer

(Lit.: Bas *& al.* 1990, Hansen & Knudsen 1992, Kreisel 1987, Pilát 1935, Singer 1986, Watling & Gregory 1989)

Phyllotopsis nidulans (Pers. : Fr.) Singer
= *Agaricus nidulans* Pers. : Fr. (1)
= *Pleurotus nidulans* (Pers. : Fr.) P. Kumm. (2)
Ref.: Focht 1974, Schulzer *& al.* 1866 (1), Tortić 1968 b, unp. Tortić ( )(2), Schulzer 1857 HR? (1)
Exs.: CNF

Pleurotus (Fr.) P. Kumm.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1990, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Hilber 1982, Konrad & Maublanc 1924--1937, Kreisel 1987, Krisai-Greilhuber & Voglmayr 1995, Pilát 1935, Singer 1986, Watling & Gregory 1989)

•***Pleurotus calyptratus*** (Lindblad) Sacc.
Ref.: Hilber 1982, Jelić & Tortić 1973, unp. Tkalčec & Mešić, unp. Tortić

Exs.: CNF, Hilber
(Lit.: Hilber 1982)

•***Pleurotus cornucopiae*** (Paulet ex Pers.) Rolland
= *Agaricus sapidus* Schulzer (1)
= *Panus sapidus* Schulzer (nom. nud.) (2)
= *Pleurotus sapidus* (Schulzer) Sacc. (3)
Ref.: Blagaić 1931 (3), Hilber 1982, Kalchbrenner & Schulzer 1873-1877 (1), Schulzer 1881 (1), Schulzer 1882 a (1), Schulzer *& al.* 1866 (2), unp. Tkalčec & Mešić, unp. Tortić, Fries 1874 HR? (1), Saccardo 1887 HR? (3)
Exs.: CNF, Hilber
(Lit.: Hilber 1982)

•***Pleurotus dryinus*** (Pers. : Fr.) P. Kumm.
= *Pleurotus corticatus* (Fr. : Fr.) P. Kumm. (1)
Ref.: Focht 1974, Hilber 1982, Kišpatić 1950 (1), unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, Hilber
(Lit.: Hilber 1982)

•***Pleurotus eryngii*** (DC. : Fr.) Quél.

•var. ***nebrodensis*** (Inzenga) Sacc.
Ref.: Hilber 1982, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, Hilber
(Lit.: Hilber 1982)

•***Pleurotus ostreatus*** (Jacq. : Fr.) P. Kumm.
= *Agaricus ostreatus* Jacq. : Fr. (1)
= *Panus ostreatus* (Jacq. : Fr.) ? (2)
= *Agaricus salignus* Pers. : Fr. (3)
= *Panus salignus* (Pers. : Fr.) ? (4)
= *Pleurotus salignus* (Pers. : Fr.) P. Kumm.
Ref.: Blagaić 1921 b, Blagaić 1931, Focht 1974, Focht 1979, Focht 1981 a, Focht 1983 a, Focht 1986, Kranjčev 1986 b, Lorinser - Janda 1877, Moesz 1938, Schulzer *& al.* 1866 (2)(4), Škorić 1928 (1), Tortić 1962, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić 1994, Urbani 1946, Vouk & Pevalek 1915 (1)(3), Vouk & Pevalek 1916 (1)(3), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)(3)
Exs.: CNF
(Lit.: Hilber 1982)

Pleurotus ostreatus (Jacq. : Fr.) P. Kumm. sensu lato
Ref.: Tortić 1989 b

•***Pleurotus pulmonarius*** (Fr. : Fr.) Quél.
= *Pleurotus ostreatus* (Jacq. : Fr.) P. Kumm. var. *pulmonarius* (Fr. : Fr.) Konrad et Maubl. (1)

Ref.: Barčić 1982 (1), Barčić 1996 (1), Focht 1983 a, Lisiewska & Tortić 1990, Tortić 1966 a (1), unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF, POZM
(Lit.: Hilber 1982)

Familia **Tricholomataceae** R. Heim ex Pouzar

Armillaria (Fr.) Staude
= *Armillariella* (P. Karst.) P. Karst.
(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1997, Hansen & Knudsen 1992, Kreisel 1987, Marxmüller 1992, Pilát 1951 b, Termorshuizen & Arnolds 1987, Volk & Burdsall 1995)

*•***Armillaria gallica*** Marxmüller et Romagn.
Misappl.: *Armillaria lutea* Gillet sensu auct. non Gillet
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Hansen & Knudsen 1992)

•***Armillaria mellea*** (Vahl : Fr.) P. Kumm.
= *Agaricus melleus* Vahl : Fr. (1)
= *Armillariella mellea* (Vahl : Fr.) P. Karst. (2)
= *Clitocybe mellea* (Vahl : Fr.) Ricken (3)
Ref.: Barčić 1982 (2), Barčić 1996 (2), Blagaić 1921 a (3), Blagaić 1931 (3), Focht 1974 (2), Focht 1981 b (2), Forenbacher 1915, Georgevitch 1926, Gjurašin 1898, Glavaš & Halambek 1992 (2), Halambek *& al.* 1993 (2), Jelić & Tortić 1973 (2), Kišpatić 1991, Kranjčev 1979, Kranjčev 1986 b (2), Kranjčev 1991 b (2), Kranjčev 1995 (2), Lange 1974, Lorinser - Janda 1877, Mužic & Božac 1984 (2), Schulzer *& al.* 1866 (1), Šarić-Sabadoš 1957, Škorić 1926 (1), Škorić 1928, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a (2), Tortić 1978 (2), Tortić 1994, Vouk & Pevalek 1915, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić 1970 (2), unp. Tortić, Schulzer 1857 HR? (1)
Exs.: BEO, CNF
(Lit.: Bas *& al.* 1995, Hansen & Knudsen 1992)

Armillaria mellea (Vahl : Fr.) P. Kumm. sensu lato
= *Armillariella mellea* (Vahl : Fr.) P. Karst. sensu lato (1)
= *Agaricus melleus* Vahl : Fr. var. *fuscopallidus* (Bolton) ? (2)
Ref.: Lisiewska & Tortić 1990, Schulzer 1867 (2), Tortić 1989 b (1), Tortić 1993

•***Armillaria ostoyae*** (Romagn.) Herink
Misappl.: *Armillaria obscura* (Schaeff.) Herink sensu auct. non Schaeff. (sensu Schaeff. = nom. dub. - Termorshuizen & Arnolds 1987)

Misappl.: *Armillariella obscura* (Schaeff.) Romagn. sensu auct. non Schaeff. (comb. inval.) (1)
Ref.: Focht 1986 (1), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995)

•***Armillaria tabescens*** (Scop.) Emel
= *Armillariella tabescens* (Scop.) Singer (1)
= *Clitocybe tabescens* (Scop.) Bres. (2)
= *Agaricus inarmillatus* Schulzer (3)
Ref.: Barčić 1982 (1), Barčić 1996 (1), Blagaić 1921 a (2), Blagaić 1931 (2), Focht 1979 (2), Focht 1981 a (2), Focht 1983 a (2), Focht 1986 (1), Kranjčev 1995 (2), Tortić 1964 (2), Tortić & Lisiewska 1978 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić 1970 (1), unp. Tortić (2), Schulzer 1883 a HR? (3)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Moser 1983)

*****Arrhenia*** Fr.
= *Leptoglossum* P. Karst.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Hansen & Knudsen 1992, Singer 1986)

****Arrhenia spathulata*** (Fr. : Fr.) Redhead
= *Leptoglossum muscigenum* (Bull. : Fr.) P. Karst. (1)
Ref.: unp. Tortić (1)
Exs.: CNF

Asterophora Ditmar : Fr.
= *Nyctalis* Fr.

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Moser 1983, Singer 1986)

•***Asterophora lycoperdoides*** (Bull. : Fr.) Ditmar
= *Nyctalis asterophora* Fr. (1)
Ref.: Kranjčev 1991 a, Kranjčev 1995, unp. Matočec (1), unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Asterophora parasitica (Bull. : Fr.) Singer
= *Nyctalis parasitica* (Bull. : Fr.) Fr.
Ref.: Focht 1974

Baeospora Singer

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Turnbull 1998)

*•**_Baeospora myosura_** (Fr. : Fr.) Singer
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Baeospora myriadophylla (Peck) Singer
Ref.: Tortić 1973, Tortić & Jelić 1970, unp. Matočec, unp. Tortić
Exs.: CNF

Calocybe Kühner ex Donk

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1977, Singer 1986)

•**_Calocybe carnea_** (Bull. : Fr.) Kühner ex Donk
Ref.: Tortić 1973, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

*•**_Calocybe chrysentera_** (Bull. : Fr.) Singer
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•**_Calocybe gambosa_** (Fr. : Fr.) Singer ex Donk
= *Agaricus gambosus* Fr. : Fr. (1)
= *Tricholoma georgii* (Clus. ex L.) Quél. var. *gambosa* (Fr. : Fr.) ? (2)
= *Agaricus georgii* Clus. ex L. (3)
= *Calocybe georgii* (Clus. ex L.) Kühner (comb. inval.) (4)
= *Tricholoma georgii* (Clus. ex L.) Quél. (5)
Ref.: Blagaić 1923 (2)(5), Blagaić 1931 (5), Focht 1979 (4), Focht 1983 b (4), Focht 1986 (5), Mužic & Božac 1984 (5), Mužic & Božac 1997 ( )(5), Tortić 1966 a (4), Tortić 1966 b (4), Tortić 1968 b (4), Vouk & Pevalek 1916 (1)(3), unp. Matočec (4), unp. Tkalčec & Mešić, unp. Tortić (5), Focht 1981 a HR? (4)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•**_Calocybe ionides_** (Bull. : Fr.) Kühner ex Donk
= *Agaricus ionides* Bull. : Fr. (1)
Ref.: Schulzer *& al.* 1866 (1), Tortić 1968 b, Tortić & Lisiewska 1978, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

*•**_Calocybe obscurissima_** (A. Pearson) Moser
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Moser 1983)

Catathelasma Lovejoy

(Lit.: Bas *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983)

Catathelasma imperiale (Fr. → Quél.) Singer
Ref.: Focht 1986, unp. Tortić
Exs.: CNF

Chaetocalathus Singer

(Lit.: Antonín & Noordeloos 1997, Bollmann *& al.* 1996, Matzke & Senn-Irlet 1992, Pilát 1935, Singer 1986)

Chaetocalathus craterellus (Durieu et Lév.) Singer
= *Pleurotus craterellus* (Durieu et Lév.) Quél. (1)
Ref.: Jaap 1916 (1), Pilát 1935 (1), Tortić 1993, unp. Kotlaba (according to unp. Tortić)
Exs.: CNF, PRM

Chrysomphalina Clémençon

(Lit.: Bollmann *& al.* 1996, Clémençon 1982 a, Hansen & Knudsen 1992, Singer 1986)

Chrysomphalina chrysophylla (Fr. : Fr.) Clémençon
= *Gerronema chrysophyllum* (Fr. : Fr.) Singer (1)
= *Omphalina chrysophylla* (Fr. : Fr.) Murrill
Ref.: Tortić 1973 (1), Tortić 1989 b (1), unp. Tortić (1)
Exs.: CNF

Clitocybe (Fr.) Staude

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1997, Bollmann *& al.* 1996, Clémençon 1984 a, Hansen & Knudsen 1992, Harmaja 1969, Kreisel 1987, Kühner & Romagnesi 1953, Kuyper 1996, Moser 1983, Singer 1978, Vouk & Pevalek 1916)

•***Clitocybe alexandri*** (Gillet) Gillet
Ref.: Božac 1984, Vrščaj 1990, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1984 a)

Clitocybe cacabus (Fr.) Gillet
= *Agaricus cacabus* Fr. (1)
Ref.: Škorić 1928 (1), unp. Tortić
Exs.: CNF ?

Clitocybe catinus (Fr.) Quél.
= *Clitocybe infundibuliformis* Schaeff. var. *catinus* (Fr.) Maire (1)
Ref.: Focht 1972, Vouk & Pevalek 1915 (1)

•***Clitocybe clavipes*** (Pers. : Fr.) P. Kumm.
Ref.: Božac 1984, Božac 1986, Božac 1989, Božac 1993, Gjurašin 1898, unp. Matočec, unp. Tkalčec & Mešić, Blagaić 1921 b ?
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1984 a)

****Clitocybe costata*** Kühner et Romagn.
= *Clitocybe infundibuliformis* (Schaeff.) Quél. var. *costata* (Kühner et Romagn.) ? (1)
Ref.: unp. Tortić ( )(1)
Exs.: CNF

Clitocybe ericetorum (Bull.) Quél.
= *Agaricus ericetorum* Bull. (1)
Ref.: Gjurašin 1898, Vouk & Pevalek 1915 (1)

Clitocybe fragrans (With. : Fr.) P. Kumm.
= *Clitocybe suaveolens* (Schumach. : Fr.) P. Kumm. (1)
Ref.: Gjurašin 1898 (1), Tortić 1968 b (1), unp. Tortić (1),
Exs.: CNF

Clitocybe gallinacea (Scop.) Gillet
Ref.: Božac 1982, Gjurašin 1898

•***Clitocybe geotropa*** (DC. et Lam.) Quél.
Ref.: Barčić 1982, Barčić 1984, Barčić 1996, Božac 1982, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1972, Focht 1979, Focht 1983 b, Focht 1986, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1984 a, Hansen & Knudsen 1992)

•***Clitocybe gibba*** (Pers. : Fr.) P. Kumm.
Misappl.: *Agaricus infundibuliformis* Schaeff. sensu auct. non Schaeff. (1)
(sensu Schaeff. = *Lepista flaccida* (Sowerby : Fr.) Pat. - Bas *& al.* 1995)
Misappl.: *Clitocybe infundibuliformis* (Schaeff.) Quél. sensu auct. non Schaeff. (2)
Ref.: Barčić 1982, Barčić 1996, Focht 1972 (2), Focht 1974( )(2), Focht 1979 (2), Gjurašin 1898 (2), Lisiewska & Tortić 1990, Tortić 1964 (2), Tortić 1966 a (2), Tortić 1966 b (2), Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (1), unp. Matočec (2), unp. Tkalčec & Mešić, unp. Tortić ( )(2)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1984 a)

Clitocybe gyrans (Paulet) Sacc.
Ref.: Focht 1974

Clitocybe incilis (Fr.) Quél.
Ref.: unp. Matočec

Clitocybe inornata (Sowerby : Fr.) Gillet
Ref.: Focht 1972, unp. Tortić
Exs.: CNF

Clitocybe lignatilis (Pers. : Fr.) P. Karst.
= *Ossicaulis lignatilis* (Pers. : Fr.) Redhead et Ginns
= *Pleurocybella lignatilis* (Pers. : Fr.) Singer (1)
= *Pleurotus lignatilis* (Pers. : Fr.) P. Kumm. (2)
Ref.: Tortić 1968 b (1), Tortić 1989 b, unp. Tortić ( )(2)
Exs.: CNF

Clitocybe metachroa (Fr. : Fr.) P. Kumm.
= *Clitocybe dicolor* (Pers.) Murrill (1)
Ref.: Barčić 1982 (1), Barčić 1996 (1), Focht 1972, Tortić 1973, unp. Tortić
Exs.: CNF

•***Clitocybe nebularis*** (Batsch : Fr.) P. Kumm.
= *Agaricus nebularis* Batsch : Fr. (1)
= *Lepista nebularis* (Batsch : Fr.) Harmaja
Ref.: Barčić 1982, Barčić 1996, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Jelić & Tortić 1973, Kranjčev 1995, Tortić 1964, Tortić 1966 a, Tortić 1966 b, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer *& al.* 1866 ? (1)
Exs.: CNF
(Lit.: Clémençon 1984 a)

•***Clitocybe obsoleta*** (Batsch) Quél.
Ref.: Focht 1974, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Clémençon 1984 a)

•***Clitocybe odora*** (Bull. : Fr.) P. Kumm.
= *Agaricus odorus* Bull. : Fr. (1)
= *Agaricus odorus* Bull. : Fr. var. *anisatus* (Pers.) ? (2)
Ref.: Focht 1979, Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1)(2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Vouk & Pevalek 1916 (1), unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF, POZM
(Lit.: Bas *& al.* 1995, Clémençon 1984 a)

Clitocybe phaeophthalma (Pers.) Kuyper
= *Clitocybe fritilliformis* (Lasch) Gillet
Misappl.: *Clitocybe hydrogramma* (Bull. : Fr.) P. Kumm. sensu auct. non Bull. (1)

Misappl.: *Hyporrhodius hydrogrammus* (Bull. : Fr.) J. Schröt. sensu auct. non Bull. (2)
Ref.: Božac 1982 (1), Lisiewska & Tortić 1990 (1), Vouk & Pevalek 1916 (2), unp. Tortić (1)
Exs.: CNF

Clitocybe phyllophila (Pers. : Fr.) P. Kumm.
= *Agaricus phyllophilus* Pers. : Fr. (1)
= *Clitocybe cerussata* (Fr. : Fr.) P. Kumm. (2)
= *Clitocybe pithyophila* (Fr.) Gillet (3)
Ref.: Božac 1982 ( )(2)(3), Focht 1979 (2), Focht 1983 b (2), Lisiewska & Tortić 1990 (2), Schulzer *& al.* 1866 (1), Tortić 1966 a (3), Tortić 1968 b, unp. Lisiewska (2), unp. Tortić (2),
Exs.: CNF, POZM (2)

Clitocybe pruinosa (Lasch) P. Kumm.
= *Clitocybe radicellata* Gillet
Ref.: Focht 1972

Clitocybe rivulosa (Pers. : Fr.) P. Kumm.
Misappl.: *Clitocybe dealbata* (Sowerby : Fr.) P. Kumm. sensu auct. p. p. non Sowerby (sensu Sowerby = nom. dub. - Bas *& al.* 1995)
Ref.: Focht 1979

•***Clitocybe sinopica*** (Fr. : Fr.) P. Kumm.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Clémençon 1984 a)

*****Clitocybe trulliformis*** (Fr. : Fr.) P. Karst.
Ref.: unp. Tortić
Exs.: CNF

Clitocybe tuba (Fr.) Gillet
Ref.: Focht 1974

Clitocybula (Singer) Métrod

(Lit.: Bollmann *& al.* 1996, Moser 1983, Singer 1978, Singer 1986)

•***Clitocybula lacerata*** (Scop.) Métrod
= *Fayodia lacerata* (Scop.) Singer (1)
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), unp. Tortić (1)
Exs.: CNF

*•var. ***odorata*** Bon
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bon 1997)

Collybia (Fr.) Staude
= *Rhodocollybia* Singer

(Lit.: Antonín & Noordeloos 1997, Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Clémençon 1981, Fries 1821, Fries 1874, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983)

Collybia acervata (Fr. : Fr.) P. Kumm.
= *Gymnopus acervatus* (Fr. : Fr.) Murrill
Ref.: Blagaić 1921 b

*•***Collybia aquosa*** (Bull. : Fr.) P. Kumm.
= *Gymnopus aquosus* (Bull. : Fr.) Antonín et Noordel.
= *Collybia dryophila* (Bull. : Fr.) P. Kumm. var. *aquosa* (Bull. : Fr.) Quél.
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Antonín & Noordeloos 1997, Bas *& al.* 1995)

•***Collybia butyracea*** (Bull. : Fr.) P. Kumm.
= *Agaricus butyraceus* Bull. : Fr. (1)
= *Rhodocollybia butyracea* (Bull. : Fr.) Lennox
= *Collybia butyracea* (Bull. : Fr.) P. Kumm. var. *asema* (Fr. : Fr.) Quél. (2)
= *Collybia asema* (Fr. : Fr.) P. Kumm. (3)
Ref.: Lisiewska & Tortić 1990, Schulzer 1867 (1), Škorić 1928 (1), Tortić 1973, Tortić & Lisiewska 1978 (2), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(3)
Exs.: CNF
(Lit.: Antonín & Noordeloos 1997, Bas *& al.* 1995, Moser 1983)

Collybia cirrhata (Pers.) P. Kumm.
= *Agaricus cirrhatus* (Pers.) ? (1)
= *Collybia amanitae* (Batsch) Kreisel (comb. inval.)
Ref.: Stoitzner 1869 (1), Tortić & Lisiewska 1978, unp. Lisiewska
Exs.: POZM

•***Collybia confluens*** (Pers. : Fr.) P. Kumm.
= *Gymnopus confluens* (Pers. : Fr.) Antonín, Halling et Noordel.
= *Marasmius archyropus* (Pers.) Fr. (1)
= *Marasmius ingratus* (Schumach. : Fr.) Quél. (2)
Ref.: Blagaić 1921 b (2), Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1968 b, Tortić 1993, Vouk & Pevalek 1916 (1), unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1981)

Collybia cookei (Bres.) J.D. Arnold
Ref.: Lisiewska & Tortić 1990, unp. Tortić
Exs.: CNF

•**_Collybia dryophila_** (Bull. : Fr.) P. Kumm.
= _Agaricus dryophilus_ Bull. : Fr. (1)
= _Gymnopus dryophilus_ (Bull. : Fr.) Murrill (2)
Ref.: Antonín & Noordeloos 1997 (2), Barčić 1982, Barčić 1996, Focht 1974, Schulzer _& al._ 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (1), unp. Kotlaba (according to unp. Tortić), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF, PRM
(Lit.: Antonín & Noordeloos 1997, Bas _& al._ 1995)

Collybia erythropus (Pers. : Fr.) P. Kumm.
= _Gymnopus erythropus_ (Pers. : Fr.) Antonín, Halling et Noordel.
= _Marasmius erythropus_ (Pers. : Fr.) Quél. (1)
= _Collybia bresadolae_ (Kühner et Romagn.) Singer (2)
= _Collybia marasmioides_ (Britzelm.) Bresinsky et Stangl (3)
Ref.: Barčić 1982 (3), Barčić 1996 (3), Schulzer _& al._ 1866 (1), Tortić 1968 b, Tortić & Lisiewska 1978 (2), unp. Lisiewska (3), unp. Tortić
Exs.: CNF, POZM (3)

Collybia fuscopurpurea (Pers. : Fr.) P. Kumm.
= _Gymnopus fuscopurpureus_ (Pers. : Fr.) Antonín, Halling et Noordel.
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

•**_Collybia fusipes_** (Bull. : Fr.) Quél.
= _Agaricus fusipes_ Bull. : Fr. (1)
= _Gymnopus fusipes_ (Bull. : Fr.) Gray
Ref.: Blagaić 1921 b, Schulzer _& al._ 1866 (1), Tortić 1964, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (1), unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF, POZM
(Lit.: Bas _& al._ 1995, Moser 1983)

•**_Collybia hariolorum_** (Bull. : Fr.) Quél.
= _Agaricus hariolorum_ Bull. : Fr. (1)
= _Gymnopus hariolorum_ (Bull. : Fr.) Antonín, Halling et Noordel. (2)
= _Marasmius hariolorum_ (Bull. : Fr.) Quél. (3)
Ref.: Antonín & Noordeloos 1997 (2), Škorić 1928 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(3)
Exs.: CNF, H, POZM, PRM
(Lit.: Antonín & Noordeloos 1997, Bas _& al._ 1995)

*•**_Collybia hybrida_** (Kühner et Romagn.) Svrček et Kubička
= _Gymnopus hybridus_ (Kühner et Romagn.) Antonín et Noordel.
Ref.: unp. Tkalčec & Mešić

Exs.: CNF
(Lit.: Clémençon 1981, Moser 1983)

•***Collybia impudica*** (Fr.) Singer
= *Gymnopus impudicus* (Fr.) Antonín, Halling et Noordel. (1)
Ref.: Antonín & Noordeloos 1997 (1)
Exs.: PRM
(Lit.: Antonín & Noordeloos 1997)

•***Collybia maculata*** (Alb. et Schwein. : Fr.) P. Kumm.
= *Rhodocollybia maculata* (Alb. et Schwein. : Fr.) Singer
Ref.: Barčić 1982, Barčić 1996, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Hansen & Knudsen 1992, Moser 1983)

•***Collybia ocior*** (Pers.) Vilgalys et O.K. Mill.
= *Gymnopus ocior* (Pers.) Antonín et Noordel. (1)
= *Collybia exculpta* (Fr.) Gillet
= *Collybia extuberans* (Fr.) Quél. (2)
= *Collybia luteifolia* Quél.
= *Collybia succinea* (Fr.) Quél.
Ref.: Antonín & Noordeloos 1997 (1), Focht 1974 (2), unp. Tkalčec & Mešić
Exs.: BRA, CNF
(Lit.: Antonín & Noordeloos 1997, Bas *& al.* 1995)

•***Collybia peronata*** (Bolton : Fr.) P. Kumm.
= *Agaricus peronatus* Bolton : Fr. (1)
= *Gymnopus peronatus* (Bolton : Fr.) Antonín, Halling et Noordel.
= *Marasmius peronatus* (Bolton : Fr.) Fr. (2)
Ref.: Blagaić 1921 b (2), Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1968 b, Tortić 1973, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (2), unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Antonín & Noordeloos 1997, Bas *& al.* 1995)

Collybia tuberosa (Bull. : Fr.) P. Kumm.
= *Marasmius tuberosus* (Bull. : Fr.) Schulzer (1)
Ref.: Schulzer *& al.* 1866 (1), Tortić 1973, unp. Tortić
Exs.: CNF

**Cyphella* Fr. : Fr.

(Lit.: Bollmann *& al.* 1996, Kreisel 1987, Singer 1986)

****Cyphella digitalis*** (Alb. et Schwein. : Fr.) Fr.
Ref.: unp. Tortić
Exs.: CNF

Delicatula Fayod

(Lit.: Kreisel 1987, Moser 1983, Singer 1986)

Delicatula cuspidata (Quél.) Cejp
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

Dermoloma (J.E. Lange) Singer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1986, Hansen & Knudsen 1992, Singer 1966, Watling & Turnbull 1998)

•***Dermoloma cuneifolium*** (Fr. : Fr.) Singer ex Bon
= *Dermoloma atrocinereum* (Pers) P.D. Orton (1)
= *Dermoloma fuscobrunneum* P.D. Orton
Ref.: Tortić 1973 (1), unp. Tkalčec & Mešić
Exs.: CNF, PRM (1)
(Lit.: Bas *& al.* 1995)

*•***Dermoloma josserandii*** Dennis et P.D. Orton
= *Dermoloma hygrophorus* Joss.
= *Dermoloma phaeopodium* P.D. Orton
= *Dermoloma pragensis* Kubička (nom. inval.)
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995)

*•***Dermoloma pseudocuneifolium*** Herink ex Bon
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995)

Flammulina P. Karst.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Fries 1821, Hansen & Knudsen 1992, Kreisel 1987)

•***Flammulina velutipes*** (Curtis : Fr.) Singer
= *Agaricus velutipes* Curtis : Fr. (1)
= *Collybia velutipes* (Curtis : Fr.) P. Kumm. (2)
Ref.: Barčić 1982, Barčić 1996, Focht 1979, Focht 1981 a, Focht 1983 a, Jelić & Tortić 1973, Schulzer *& al.* 1866 (1), Tortić 1962 (2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1989 b, Vouk & Pevalek 1915 (1), Vouk & Pevalek 1916 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(2), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1995)

Gerronema Singer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1997, Clémençon 1982 a, Dennis *& al.* 1960, Fries 1836-1838, Hansen & Knudsen 1992, Kreisel 1987, Singer 1975, Singer 1986)

Gerronema ericetorum (Pers. : Fr.) Singer
= *Omphalina ericetorum* (Pers. : Fr.) M. Lange (1)
= *Phytoconis ericetorum* (Pers. : Fr.) Redhead et Kuyper
Misappl.: *Omphalia umbellifera* (L. : Fr.) P. Kumm. sensu auct. non L. (2)
Misappl.: *Omphalina umbellifera* (L. : Fr.) Quél. sensu auct. non L. (3)
Ref.: Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1968 a (1), unp. Tortić (2)
Exs.: CNF

•***Gerronema grossulum*** (Pers.) Singer
= *Camarophyllus grossulus* (Pers.) Clémençon
= *Omphalina grossula* (Pers.) Singer (1)
= *Omphalia abiegna* (Berk. et Broome) J.E. Lange (2)
= *Omphalina abiegna* (Berk. et Broome) Singer (3)
= *Omphalina wynniae* (Berk. et Broome) S. Ito (4)
Ref.: Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1968 a (4), Tortić 1968 b (3), Tortić 1989 b (1), unp. Tkalčec & Mešić, unp. Tortić (2)(3)
Exs.: CNF
(Lit.: Clémençon 1982 a, Hansen & Knudsen 1992, Moser 1983)

Gerronema umbilicatum (Schaeff.) Singer
= *Clitocybe umbilicata* (Schaeff.) P. Kumm. (1)
= *Omphalina umbilicata* (Schaeff.) Quél.
Ref.: Focht 1972 (1)

Hemimycena Singer

(Lit.: Arnolds *& al.* 1995, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kreisel 1987, Maas Geesteranus 1992 a, Singer 1986, Watling & Turnbull 1998)

Hemimycena cucullata (Pers. : Fr.) Singer
= *Agaricus cucullatus* Pers. : Fr. (1)
= *Mycena nivea* Quél. (2)
Ref.: Gjurašin 1898 (2), Vouk & Pevalek 1916 (1)

Hemimycena gracilis (Quél.) Singer
= *Mycena gracilis* (Quél.) Kühner (1)
Ref.: Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF

Hemimycena lactea (Pers. : Fr.) Singer
= *Mycena lactea* (Pers. : Fr.) P. Kumm. (1)
= *Hemimycena delicatella* (Peck) Singer (2)

Ref.: Focht 1974 (1), unp. Tortić (2)
Exs.: CNF

Hohenbuehelia Schulzer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1989)

Hohenbuehelia atrocoerulea (Fr. : Fr.) Singer
= *Agaricus atrocoeruleus* Fr. : Fr. (1)
Ref.: Schulzer *& al.* 1866 (1), unp. Tortić
Exs.: CNF

•***Hohenbuehelia mastrucata*** (Fr. : Fr.) Singer
Ref.: Stropnik *& al.* 1988, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Hansen & Knudsen 1992, Watling & Gregory 1989)

•***Hohenbuehelia petaloides*** (Bull. : Fr.) Schulzer
= *Pleurotus petaloides* (Bull. : Fr.) Quél. (1)
= *Agaricus geogenius* DC. : Fr. (2)
= *Hohenbuehelia geogenia* (DC. : Fr.) Singer (3)
= *Pleurotus geogenius* (DC. : Fr.) Gillet (4)
Ref.: Barčić 1982, Barčić 1996, Focht 1972 (3), Focht 1974 (3), Focht 1986 (3), Schulzer *& al.* 1866, Tortić 1989 b, Vouk & Pevalek 1915 (2), Vrščaj 1990 (3), unp. Tkalčec & Mešić, unp. Tortić ( )(1)(3)(4)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Watling & Gregory 1989)

MOST PROBABLY FOUND IN THE TERRITORY OF CROATIA

Hohenbuehelia repanda Huijsman
Ref.: Focht 1986 HR?

Hydropus Kühner ex Singer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Turnbull 1998)

Hydropus atramentosus (Kalchbr.) Kotl. et Pouzar
Ref.: Tortić 1973
Exs.: PRM

Hydropus marginellus (Pers. : Fr.) Singer
Ref.: Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1973, Tortić 1989 b, unp. Tortić
Exs.: CNF

*•***Hydropus subalpinus** (Höhn.) Singer
Ref.: unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983, Watling & Turnbull 1998)

Hypsizygus Singer

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Moser 1983, Singer 1986, Watling & Gregory 1989)

Hypsizygus circinatus (Fr.) Singer
Ref.: Tortić 1989 b, unp. Tortić

•***Hypsizygus ulmarius*** (Bull. : Fr.) Redhead
= *Lyophyllum ulmarium* (Bull. : Fr.) Kühner (1)
= *Panus ulmarius* (Bull. : Fr.) Schulzer (2)
= *Pleurotus ulmarius* (Bull. : Fr.) P. Kumm. (3)
Ref.: Schulzer *& al.* 1866 (2), Tortić 1964 (1), Tortić 1989 b (1), unp. Tkalčec & Mešić, unp. Tortić (1)(3)
Exs.: CNF
(Lit.: Moser 1983, Pilát 1935, Watling & Gregory 1989)

Laccaria Berk. et Broome

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Clémençon 1984 b, Fries 1821, Hansen & Knudsen 1992, Kreisel 1987, Mueller & Vellinga 1986)

•***Laccaria amethystina*** (Huds. →) Cooke
= *Clitocybe laccata* (Scop. : Fr.) P. Kumm. var. *amethystina* (Huds. → Cooke) ? (1)
= *Laccaria laccata* (Scop. : Fr.) Berk. et Broome var. *amethystina* (Huds. → Cooke) Rea (2)
= *Laccaria amethystea* (Bull. → Gray) Murrill (3)
Ref.: Barčić 1982, Barčić 1996, Blagaić 1921 b (1), Gjurašin 1898 (2), Lisiewska & Tortić 1990 (3), Tortić 1964 (3), Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1968 a (3), Tortić & Lisiewska 1978, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(3)
Exs.: BEO, CNF
(Lit.: Bas *& al.* 1995, Clémençon 1984 b)

****Laccaria bicolor*** (Maire) P.D. Orton
Ref.: unp. Matočec
Exs.: CNF

•***Laccaria laccata*** (Scop. : Fr.) Berk. et Broome
= *Agaricus laccatus* Scop. : Fr. (1)
= *Russuliopsis laccata* (Scop. : Fr.) J. Schröt. (2)
= *Laccaria tetraspora* Singer (3)

Ref.: Barčić 1982, Barčić 1996, Kišpatić 1950 (2), Jelić & Tortić 1973, Lisiewska & Tortić 1990, Schulzer 1867 (1), Škorić 1928 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (1), unp. Matočec ( )(3), unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1984 b)

Laccaria proxima (Boud.) Pat.
Ref.: Lisiewska & Tortić 1990

Lachnella Fr.

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Singer 1986)

Lachnella alboviolascens (Alb. et Schwein. : Fr.) Fr.
= *Cyphella alboviolascens* (Alb. et Schwein. : Fr.) Crouan (1)
Ref.: Jaap 1916 (1)

Lachnella villosa (Pers. : Fr.) Gillet
= *Cyphella villosa* (Pers. : Fr.) Crouan (1)
Ref.: Jaap 1916 (1), Picbauer 1928 (1)

Lepista (Fr.) W.G. Sm.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Bon 1983, Bon 1997, Dennis *& al.* 1960, Hansen & Knudsen 1992, Konrad & Maublanc 1924-1937, Kreisel 1987, Moser 1983, Pilát 1951 b, Singer 1986)

*•***Lepista caespitosa*** (Bres.) Singer
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Moser 1983)

•***Lepista flaccida*** (Sowerby : Fr.) Pat.
= *Agaricus flaccidus* Sowerby : Fr. (1)
= *Clitocybe flaccida* (Sowerby : Fr.) P. Kumm. (2)
= *Agaricus infundibuliformis* Schaeff.
= *Clitocybe infundibuliformis* (Schaeff.) Quél. non sensu auct.
= *Agaricus inversus* Scop. (3)
= *Clitocybe inversa* (Scop.) Quél. (4)
= *Lepista inversa* (Scop.) Pat.
Ref.: Focht 1972 (4), Focht 1974 (2), Focht 1979 (2), Gjurašin 1898 (4), Mužic & Božac 1997 (4), Schulzer *& al.* 1866 (1), Škorić 1928 (3), Tortić 1964 (4), Tortić 1966 a (4), Tortić 1966 b (4), Tortić & Lisiewska 1978 (4), unp. Matočec (4), unp. Tkalčec & Mešić, unp. Tortić (4)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Hansen & Knudsen 1992, Moser 1983)

*•***Lepista gilva** (Pers. : Fr.) Pat.
= *Clitocybe gilva* (Pers. : Fr.) P. Kumm. (1)
Ref.: unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•**Lepista glaucocana** (Bres.) Singer
= *Tricholoma nudum* (Bull. : Fr.) P. Kumm. var. *glaucocanum* (Bres.) L. Maire (1)
Ref.: Božac 1984, Božac 1986, Božac 1989, Božac 1993, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Bon 1983, Moser 1983)

Lepista irina (Fr.) H.E. Bigelow
= *Tricholoma irinum* (Fr.) P. Kumm. (1)
Ref.: Božac 1982 (1), Božac 1984, Božac 1986, Božac 1989, Božac 1993

•**Lepista nuda** (Bull. : Fr.) Cooke
= *Agaricus nudus* Bull. : Fr. (1)
= *Rhodopaxillus nudus* (Bull. : Fr.) Maire (2)
= *Tricholoma nudum* (Bull. : Fr.) P. Kumm. (3)
Ref.: Barčić 1989, Barčić 1996, Blagaić 1921 b (3), Blagaić 1931 (3), Focht 1972 (2), Focht 1979 (2), Focht 1986, Gjurašin 1898 (3), Jelić & Tortić 1973, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(2)(3)
Exs.: CNF
(Lit.: Bon 1983, Moser 1983)

•**Lepista saeva** (Fr.) P.D. Orton
= *Agaricus bicolor* Pers. (1)
Misappl.: *Lepista personata* (Fr. : Fr.) Cooke sensu auct. non Fr. (2)
(sensu Fr. = *Lepista nuda* (Bull. : Fr.) Cooke - Dennis *& al.* 1960)
Ref.: Vouk & Pevalek 1916 (1), Vrščaj 1990 (2), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Moser 1983)

Lepista sordida (Schumach. : Fr.) Singer
= *Rhodopaxillus sordidus* (Schumach. : Fr.) Maire (1)
Ref.: Tortić 1968 b, unp. Tortić (1)
Exs.: CNF

Leucopaxillus Boursier

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Bon 1991, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Schulzer 1867, Schulzer *& al.* 1866, Singer 1986)

Leucopaxillus candidus (Bres.) Singer
= *Agaricus candidus* (Bres.) Škorić (1)
= *Clitocybe candida* Bres. (2)
Ref.: Božac 1984 (2), Božac 1986 (2), Božac 1989 (2), Božac 1993 (2), Schulzer 1885 (2), Škorić 1928 (1), Vrščaj 1990

Leucopaxillus cerealis (Lasch) Singer
= *Leucopaxillus lentus* (H. Post) Singer et A.H. Sm. (1)
Ref.: Lisiewska & Tortić 1990 (1), unp. Tortić (1)
Exs.: CNF

•***Leucopaxillus compactus*** (Fr.) Neuhoff
= *Leucopaxillus tricolor* (Peck) Kühner
Ref.: Vrščaj 1990, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•***Leucopaxillus gentianeus*** (Quél.) Kotl.
Misappl.: *Clitocybe amara* (Alb. et Schwein. : Fr.) P. Kumm. sensu auct. non Alb. et Schwein. (1)
Misappl.: *Leucopaxillus amarus* (Alb. et Schwein. : Fr.) Kühner sensu auct. non Alb. et Schwein. (2)
Ref.: Tortić 1964 (2), Tortić 1966 a (2), Tortić 1966 b (2), Tortić 1968 a (2), Tortić & Jelić 1970 (2), unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić (1)(2)
Exs.: CNF, POZM
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Leucopaxillus giganteus (Sibth. : Fr.) Singer
= *Clitocybe gigantea* (Sibth. : Fr.) Quél. (1)
= *Paxillus giganteus* (Sibth. : Fr.) Fr. (2)
Ref.: Barčić 1982 (1), Barčić 1996 (1), Blagaić 1931 (2), Focht 1979 (1)

•***Leucopaxillus macrocephalus*** (Schulzer) Bohus
= *Agaricus macrocephalus* Schulzer (1)
= *Porpoloma macrocephalum* (Schulzer) Bon
= *Agaricus megacephalus* Schulzer (nom. nud.) (2)
- as *Agaricus macrorhizus* Lasch (nom. illeg.) (3)
- as *Tricholoma macrorhizum* (Lasch) → Sacc. (4)
Ref.: Kalchbrenner & Schulzer 1873-1877 (1), Schulzer *& al.* 1866 (2) + Schulzer 1867 (nom. nud.) (1), Fries 1874 HR? (3), Saccardo 1887 HR? (4), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bon 1991, Moser 1983)
Annotation: Fries (1874) and Saccardo (1887) quote Schulzer's records (they do not precisely quote the locality) regarding *Agaricus macrocephalus* a synonym of *A. macrorhizus*. Bon (1991) considers that *A. macrocephalus* and *A. macrorhizus* are two different species of genus *Porpoloma*.

Leucopaxillus paradoxus (Costantin et L.M. Dufour) Boursier
= *Clitocybe paradoxa* Costantin et L.M. Dufour (1)
Ref.: Tortić 1964, Vrščaj 1990, unp. Lisiewska, unp. Tortić ( )(1)
Exs.: CNF, POZM

Lyophyllum P. Karst.
= *Tephrocybe* Donk

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Clémençon 1986, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kreisel 1987, Kühner & Romagnesi 1953, Moser 1983, Pilát 1951 b, Singer 1986)

Lyophyllum atratum (Fr. : Fr.) Singer
= *Agaricus atratus* Fr. : Fr. (1)
= *Tephrocybe atrata* (Fr. : Fr.) Donk
Ref.: Škorić 1928 (1)

Lyophyllum connatum (Schumach. : Fr.) Singer
Ref.: Focht 1972, Focht 1979, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Matočec, unp. Tortić
Exs.: CNF

•***Lyophyllum deliberatum*** (Britzelm.) Kreisel
= *Lyophyllum infumatum* (Bres.) Kühner (1)
Ref.: Tortić 1968 b (1), Tortić & Lisiewska 1978 (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Clémençon 1986)

Lyophyllum fumosum (Pers. : Fr.) P.D. Orton **sensu lato**
Incl.: *Lyophyllum aggregatum* (Schaeff.) Kühner (1)
    Lyophyllum cartilagineum (Bull.) ? (2)
    Lyophyllum cinerascens (Bull.) Konrad et Maubl. (3)
    Lyophyllum conglobatum (Vittad.) Moser (4)
        = *Clitocybe conglobata* (Vittad.) Bres. (5)
        = *Tricholoma conglobatum* (Vittad.) Ricken (6)
        = *Lyophyllum aggregatum* (Schaeff.) Kühner subsp. *conglobatum* (Vittad.) ? (7)
    Lyophyllum decastes (Fr. : Fr.) Singer (8)
    Lyophyllum fumosum (Pers. : Fr.) P.D. Orton (9)
        = *Agaricus fumosus* Pers. : Fr. (10)
    Lyophyllum loricatum (Fr.) Kühner (11)
    Lyophyllum tumulosum (Kalchbr.) ? (12)
        = *Tricholoma tumulosum* (Kalchbr.) Barla (13)
        = *Agaricus tumulosus* Kalchbr. (14)
= *Lyophyllum aggregatum* (Schaeff.) Kühner sensu lato (15)

Ref.: Barčić 1982 (8), Barčić 1996 (8), Blagaić 1931 (6)(13), Božac 1984 (12), Božac 1989 (2), Božac 1993 (2), Focht 1972 (7), Focht 1979 (1)(2)(3), Focht 1981 b (11), Focht 1983 a (11), Focht 1986 (8)(15), Schulzer 1880 b (14), Škorić 1928 (10), Tortić 1964 (4), Tortić 1966 a (15), Tortić 1966 b (1), Tortić & Lisiewska 1978 (9), unp. Lisiewska (9), unp. Tortić (5)(6)(11)
Exs.: CNF, POZM (9)
Annotation: Most modern authors distinguish three species here, but disagreements exist about species concepts, synonymy and nomenclature (see Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983).

Lyophyllum inolens (Fr.) Singer
= *Agaricus inolens* Fr. (1)
= *Tephrocybe inolens* (Fr.) Moser
Ref.: Vouk & Pevalek 1916 (1)

*•***Lyophyllum macrosporum*** Singer
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Clémençon 1986)

Lyophyllum paelochroum Clémençon
Misappl.: *Lyophyllum immundum* (Berk.) Kühner sensu auct. non Berk. (1)
(sensu Berk. = nom. dub. - Clémençon 1986)
Ref.: Tortić 1966 a (1), unp. Tortić (1)
Exs.: CNF

•***Lyophyllum rancidum*** (Fr. : Fr.) Singer
= *Tephrocybe rancida* (Fr. : Fr.) Donk (1)
Ref.: Jelić & Tortić 1973 (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

*•***Lyophyllum rhopalopodium*** Clémençon
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Clémençon 1986)

•***Lyophyllum semitale*** (Fr. : Fr.) Kühner
Ref.: Božac 1984, Focht 1972, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Clémençon 1986)

•***Lyophyllum transforme*** (Britzelm.) Singer
= *Lyophyllum trigonosporum* (Bres.) Kühner (1)
Ref.: Tortić 1968 b (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Clémençon 1986)

***Macrocystidia* Joss.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983)

*•***Macrocystidia cucumis*** (Pers. : Fr.) Joss.
Ref.: unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Moser 1983)

Marasmiellus Murrill

(Lit.: Antonín & Noordeloos 1993, Antonín & Noordeloos 1997, Arnolds *& al.* 1995, Bas *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Schulzer 1867, Schulzer *& al.* 1866, Singer 1986)

****Marasmiellus candidus*** (Bolton) Singer
= *Marasmiellus albus-corticis* (Secr.) ex Singer (1)
Ref.: unp. Tortić (1)
Exs.: CNF

Marasmiellus omphaliformis (Kühner) Noordel.
= *Marasmius omphaliformis* Kühner (1)
Ref.: Focht 1974 (1)

Marasmiellus ramealis (Bull. : Fr.) Singer
= *Agaricus ramealis* Bull. : Fr. (1)
= *Marasmius ramealis* (Bull. : Fr.) Fr. (2)
= *Marasmiellus amadelphus* (Bull. : Fr.) Moser
= *Marasmius exalbidus* Schulzer (nom. nud.) (3)
Ref.: Schulzer *& al.* 1866 (3) + Schulzer 1867 (1), Tortić 1968 b (2), Tortić 1989 b, Tortić & Lisiewska 1978, unp. Tortić (2)
Exs.: CNF

****Marasmiellus tricolor*** (Alb. et Schwein. : Fr.) Singer
Ref.: unp. Tortić
Exs.: CNF

Marasmius Fr.
= *Setulipes* Antonín

(Lit: Antonín & Noordeloos 1993, Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Clémençon 1982 b, Fries 1821, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986)

•***Marasmius alliaceus*** (Jacq. : Fr.) Fr.
= *Marasmius alliaceus* (Jacq. : Fr.) Fr. var. *subtilis* J.E. Lange (nom. inval.) (1)

Ref.: Antonín & Noordeloos 1993, Blagaić 1931, Lange 1974, Lisiewska 1993, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1968 b, Tortić 1989 b, Tortić 1993, Vouk & Pevalek 1915, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: BEO, BRNM, CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 c)

•***Marasmius androsaceus*** (L. : Fr.) Fr.
= *Setulipes androsaceus* (L. : Fr.) Antonín (1)
Ref.: Antonín & Noordeloos 1993 (1), Lisiewska & Tortić 1990, Moesz 1938, Škorić 1928, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: BP, CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 c)

Marasmius bulliardii Quél.
Ref.: Jelić & Tortić 1973, Lisiewska & Tortić 1990, Tortić 1968 b, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

Marasmius cohaerens (Pers. : Fr.) Cooke et Quél.
= *Agaricus cohaerens* Pers. : Fr. (1)
Ref.: Škorić 1928 (1), unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF

Marasmius corbariensis (Roum.) Singer
= *Marasmius hygrometricus* (Brig.) Sacc. (1)
Ref.: Saccardo 1887 (1)

*•***Marasmius curreyi*** Berk. et Broome
Misappl.: *Marasmius graminum* (Lib.) Berk. sensu auct. recent. non Lib. (1)
Ref.: unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

Marasmius epiphyllus (Pers. : Fr.) Fr.
= *Agaricus epiphyllus* Pers. : Fr. (1)
Ref.: Focht 1974, Schulzer *& al.* 1866, Schulzer 1857 HR? (1)

•***Marasmius oreades*** (Bolton : Fr.) Fr.
= *Agaricus oreades* Bolton : Fr. (1)
Ref.: Blagaić 1921 a, Blagaić 1931, Božac 1982, Focht 1972, Focht 1974, Focht 1979, Gjurašin 1898, Lorinser - Janda 1877, Schulzer *& al.* 1866 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

Marasmius querceus Britzelm.
Misappl.: *Marasmius prasiosmus* (Fr. : Fr.) Fr. sensu Fr. 1836-1838 et auct. non Fr. 1818 (1)
Ref.: Blagaić 1921 b (1), Gjurašin 1898 (1), unp. Tortić (1)
Exs.: CNF

*•***Marasmius quercophilus*** Pouzar
= *Setulipes quercophilus* (Pouzar) Antonín
Misappl.: *Marasmius splachnoides* (Hornem. : Fr.) Fr. sensu auct. non Hornem.
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

•***Marasmius rotula*** (Scop. : Fr.) Fr.
= *Agaricus rotula* Scop. : Fr. (1)
Ref.: Blagaić 1921 b, Lisiewska & Tortić 1990, Schulzer 1882 a (1), Schulzer *& al.* 1866, Škorić 1928, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1973, Tortić 1979, Tortić 1989 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

•***Marasmius scorodonius*** (Fr. : Fr.) Fr.
= *Marasmius alliatus* (Schaeff.) J. Schröt. (1)
Ref.: Blagaić 1921 b, Blagaić 1931, Focht 1974, Lisiewska & Tortić 1990, Škorić 1928 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Vouk & Pevalek 1916 (1), unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

•***Marasmius torquescens*** Quél.
Misappl.: *Marasmius lupuletorum* (Weinm.) Bres. sensu auct. non Weinm. (1)
(sensu Weinm. = nom. dub. - Clémençon 1982 b)
Ref.: Lisiewska & Tortić 1990 (1), Tortić 1993 (1), unp. Lisiewska (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF, POZM (1)
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

*****Marasmius undatus*** (Berk.) Fr.
= *Marasmius chordalis* Fr. (1)
Ref.: unp. Tortić (1)
Exs.: CNF

•***Marasmius wynnei*** Berk. et Broome
= *Marasmius bresadolae* Schulzer (1)

Ref.: Lisiewska & Tortić 1990, Saccardo 1887 (1), Schulzer 1885 (1), Tortić 1968 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Clémençon 1982 b)

Megacollybia Kotl. et Pouzar

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Watling & Turnbull 1998)

•***Megacollybia platyphylla*** (Pers. : Fr.) Kotl. et Pouzar
= *Collybia platyphylla* (Pers. : Fr.) P. Kumm. (1)
= *Oudemansiella platyphylla* (Pers. : Fr.) Moser (2)
Ref.: Jelić & Tortić 1973 (2), Lisiewska & Tortić 1990, Tortić 1966 a (2), Tortić 1966 b (2), Tortić 1968 b (2), Tortić 1989 b (2), Tortić 1993, Tortić & Lisiewska 1978 (2), unp. Lindtner (1) (according to unp. Tortić), unp. Matočec (1), unp. Tkalčec & Mešić, unp. Tortić (1)(2)
Exs.: BEO (1)(2), CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Melanoleuca Pat.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bollmann *& al.* 1996, Bon 1991, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Turnbull 1998)

Melanoleuca brevipes (Bull. : Fr.) Pat.
= *Agaricus brevipes* Bull. : Fr. (1)
Ref.: Schulzer 1867 (1), unp. Tortić
Exs.: CNF

•***Melanoleuca cognata*** (Fr.) Konrad et Maubl.
Ref.: Božac 1984, Tortić 1973, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999)

Melanoleuca grammopodia (Bull. : Fr.) Pat.
Ref.: Tortić 1964, unp. Tortić

Melanoleuca melaleuca (Pers. : Fr.) Murrill **sensu lato**
Incl.: *Melanoleuca melaleuca* (Pers. : Fr.) Murrill (1)
Melanoleuca polioleuca (Fr.) Kühner et Maire
Melanoleuca vulgaris (Pat.) Pat. (2)
Ref.: Barčić 1982 (1), Barčić 1996 (1), Focht 1972 (1), Focht 1974 (2), Tortić 1973 (1), unp. Tortić ( )(1)
Exs.: CNF
Annotation: These three species belong to the species complex about which different opinions exist (see Arnolds *& al.* 1995, Bon 1991, Hansen & Knudsen 1992, Kreisel 1987, Watling & Turnbull 1998).

Melanoleuca schumacheri (Fr. : Fr.) Singer
= *Agaricus schumacheri* Fr. : Fr. (1)
Ref.: Vouk & Pevalek 1915 (1)

Melanoleuca strictipes (P. Karst.) Murrill
Ref.: Barčić 1982, Barčić 1996

Micromphale (Nees) Gray

(Lit.: Antonín & Noordeloos 1997, Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Kreisel 1987)

•***Micromphale brassicolens*** (Romagn.) P.D. Orton

•var. ***brassicolens***
= *Gymnopus brassicolens* (Romagn.) Antonín et Noordel. var. *brassicolens* (1)
= *Marasmius brassicolens* Romagn. (2)
Ref.: Antonín & Noordeloos 1997 (1), unp. Tkalčec & Mešić, unp. Tortić (2)
Exs.: CNF, PRM
(Lit.: Antonín & Noordeloos 1997)

•***Micromphale foetidum*** (Sowerby : Fr.) Singer
= *Marasmiellus foetidus* (Sowerby : Fr.) Antonín, Halling et Noordel.
= *Marasmius foetidus* (Sowerby : Fr.) Fr. (1)
Ref.: Focht 1974 (1), Tortić 1968 b (1), Tortić 1989 b, unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Antonín & Noordeloos 1997)

•***Micromphale perforans*** (Hoffm. : Fr.) Gray
= *Marasmiellus perforans* (Hoffm. : Fr.) Antonín, Halling et Noordel.
= *Marasmius perforans* (Hoffm. : Fr.) Fr. (1)
Ref.: Blagaić 1931 (1), Lisiewska & Tortić 1990, Stoitzner 1869 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 b (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Antonín & Noordeloos 1997)

Mycena (Pers.) Roussel

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Lisiewska 1987, Maas Geesteranus 1992 a, Maas Geesteranus 1992 b, Moser 1983, Singer 1986)

Mycena acicula (Schaeff.) P. Kumm.
= *Agaricus acicula* Schaeff. (1)
Ref.: Schulzer *& al.* 1866 (1), Schulzer 1857 HR? (1)

Mycena amicta (Fr. : Fr.) Quél.
Ref.: Tortić 1973, Tortić 1989 b, unp. Tortić
Exs.: CNF

Mycena atroalba (Bolton : Fr.) Gray
Ref.: Lisiewska & Tortić 1990, unp. Tortić

Mycena aurantiomarginata (Fr. : Fr.) Quél.
Ref.: Tortić 1973, unp. Tortić
Exs.: CNF

Mycena capillaris (Schumach. : Fr.) P. Kumm.
Ref.: Vouk & Pevalek 1915

Mycena crocata (Schrad. : Fr.) P. Kumm.
= *Agaricus crocatus* Schrad. : Fr. (1)
Ref.: Blagaić 1921 b, Lange 1974, Lisiewska 1993, Lisiewska & Tortić 1990, Škorić 1928 (1), Tortić 1968 b, Tortić 1973, Tortić 1989 b, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM, PRM

Mycena epipterygia (Scop. : Fr.) Gray
= *Agaricus epipterygius* Scop. : Fr. (1)
= *Mycena citrinella* (Pers. : Fr.) P. Kumm. (2)
= *Mycena viscosa* Maire (3)
Ref.: Gjurašin 1898 (2), Tortić 1964, Tortić 1966 a ( )(3), Tortić 1966 b ( )(3), Tortić 1968 b (3), Tortić 1989 b (3), Tortić 1994 (3), Tortić & Lisiewska 1978, Vouk & Pevalek 1915 (1), unp. Tortić ( )(3)
Exs.: CNF

Mycena erubescens Höhn.
Ref.: Tortić 1973, unp. Tortić
Exs.: CNF, PRM

Mycena fagetorum (Fr.) Gillet
= *Agaricus marcescens* Schulzer (1)
Ref.: Schulzer 1878 (1)

Mycena filopes (Bull. : Fr.) P. Kumm.
= *Agaricus filopes* Bull. : Fr. (1)
= *Marasmius filopes* (Bull. : Fr.) Schulzer (2)
= *Mycena iodiolens* S. Lundell (3)
Misappl.: *Mycena vitilis* (Fr.) Quél. sensu Kühner non Fr.
Ref.: Lisiewska & Tortić 1990, Schulzer 1882 a (1), Schulzer *& al.* 1866 (2), Vouk & Pevalek 1915 (1), Vouk & Pevalek 1916 (1), unp. Tortić ( )(3)
Exs.: CNF

Mycena flavoalba (Fr.) Quél.
Ref.: Lisiewska & Tortić 1990, Tortić 1973, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM, PRM

Mycena galericulata (Scop. : Fr.) Gray
= *Agaricus galericulatus* Scop. : Fr. (1)
= *Marasmius galericulatus* (Scop. : Fr.) Schulzer (2)
= *Agaricus galeriformis* Schulzer (3)
= *Agaricus pseudoclypeatus* Bolton var. *radicans* Schulzer (4)
= *Agaricus pseudoclypeatus* Bolton var. *slavonicus* Schulzer (5)
= *Agaricus rugatoplicatus* Schulzer (6)
= *Agaricus rugatulosus* Schulzer (7)
= *Agaricus rugosus* Fr. var. *stipite-elongato* Schulzer (8)
= *Mycena sparsa* (Bres. et Schulzer) Sacc. (9)
= *Mycena galericulata* (Scop. : Fr.) Gray var. *sparsa* Bres. et Schulzer (nom. illeg.) (10)
= *Mycena sudora* (Fr.) Gillet (11)
Ref.: Gjurašin 1898 (11), Jelić & Tortić 1973, Picbauer 1928, Pilát 1925, Schulzer 1878 (8), Schulzer 1879 (4), Schulzer 1880 a (5)(6)(7), Schulzer 1881 (3), Schulzer 1882 a (1), Schulzer 1885 (10), Schulzer *& al.* 1866 (2), Tortić 1966 a, Tortić 1968 b, Tortić 1973, Tortić 1989 b, Tortić 1993, Tortić & Lisiewska 1978, unp. Tortić, Saccardo 1887 HR? (9), Schulzer 1857 HR? (1)
Exs.: CNF

•***Mycena galopus*** (Pers. : Fr.) P. Kumm. ("*galopoda*")
Ref.: Barčić 1982, Barčić 1996, Jelić & Tortić 1973, Lisiewska & Tortić 1990, Tortić 1973, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Maas Geesteranus 1992 b, Moser 1983)

Mycena haematopus (Pers. : Fr.) P. Kumm. ("*haematopoda*")
Ref.: Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1979, Tortić 1989 b, Tortić 1993, unp. Tortić
Exs.: CNF

****Mycena hiemalis*** (Osbeck) Quél.
Ref.: unp. Tortić
Exs.: CNF

Mycena inclinata (Fr.) Quél.
= *Agaricus amoenipes* Schulzer var. *hirtipes* Schulzer (1)
Ref.: Jelić & Tortić 1973, Schulzer 1878 (1), Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

Mycena latifolia (Peck) A.H. Sm.
Ref.: Tortić 1973, unp. Tortić
Exs.: CNF

Mycena leptocephala (Pers. : Fr.) Gillet
= *Mycena chlorinella* (J.E. Lange) Singer (1)
Ref.: Lisiewska & Tortić 1990 (1), unp. Tortić (1)

Mycena maculata P. Karst.
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

Mycena metata (Fr. : Fr.) P. Kumm.
= *Mycena phyllogena* (Pers.) Singer (1)
Misappl.: *Mycena tenella* (Schumach.) Quél. sensu Ricken, Kühner non Schumach. (2)
(sensu Schumach. = nom. dub. - Maas Geesteranus 1992 a)
Ref.: Tortić 1973 (1), unp. Tortić (2)
Exs.: CNF

Mycena niveipes (Murrill) Murrill
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

•***Mycena pelianthina*** (Fr. : Fr.) Quél.
Ref.: Barčić 1982, Barčić 1996, Lange 1974, Lisiewska & Tortić 1990, Tortić 1973, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Hansen & Knudsen 1992, Maas Geesteranus 1992 b)

Mycena polygramma (Bull. : Fr.) Gray
= *Agaricus polygrammus* Bull. : Fr. (1)
= *Marasmius polygrammus* (Bull. : Fr.) Schulzer (2)
Ref.: Schulzer 1857 (1), Schulzer *& al.* 1866 (2), Tortić & Lisiewska 1978, Vouk & Pevalek 1915 (1), Vouk & Pevalek 1916 (1), unp. Tortić
Exs.: CNF

•***Mycena pura*** (Pers. : Fr.) P. Kumm.
= *Agaricus purus* Pers. : Fr. (1)
Ref.: Barčić 1989, Barčić 1996, Focht 1974, Gjurašin 1898, Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1994, Tortić & Lisiewska 1978, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Maas Geesteranus 1992 b)

•***Mycena renati*** Quél.
= *Mycena flavipes* Quél. (nom. illeg.) (1)
Ref.: Blagaić 1921 b, Lisiewska & Tortić 1990, Tortić 1973, Tortić 1989 b, unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF, POZM
(Lit.: Maas Geesteranus 1992 b)

*•***Mycena rorida*** (Fr. : Fr.) Quél.
Ref.: unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Mycena rosea (Bull. →) Gramberg
= *Agaricus roseus* Bull. (nom. illeg.) (1)
= *Agaricus purus* Pers. : Fr. var. *roseus* (Bull. →) Pers. (2)
Ref.: Vouk & Pevalek 1916 (1), unp. Tortić, Schulzer 1857 HR? (2)

•***Mycena rosella*** (Fr. : Fr.) P. Kumm.
= *Agaricus roseus* Pers. (nom. illeg.)
Ref.: Tortić 1973, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Mycena rubromarginata (Fr. : Fr.) P. Kumm.
Ref.: Lisiewska & Tortić 1990, Tortić 1989 b, unp. Tortić
Exs.: CNF

Mycena sanguinolenta (Alb. et Schwein. : Fr.) P. Kumm.
Ref.: Kišpatić 1950, Lisiewska & Tortić 1990, unp. Tortić
Exs.: CNF

•***Mycena seynii*** Quél.
Ref.: Focht 1974, unp. Matočec, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Maas Geesteranus 1992 b, Moser 1983)

*_**Mycena speirea**_ (Fr. : Fr.) Gillet
Ref.: unp. Tortić
Exs.: CNF

Mycena stipata Maas Geest. et Schwöbel
Misappl.: *Mycena alcalina* (Fr. : Fr.) P. Kumm. sensu auct. non Fr. (1)
(sensu Fr. = nom. dub. - Maas Geesteranus 1992 a)
Ref.: Focht 1974 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1989 b (1), Tortić 1993 (1), unp. Tortić (1)
Exs.: CNF

Mycena stylobates (Pers. : Fr.) P. Kumm.
= *Marasmius torquatus* (Fr. : Fr.) Fr. (1)
Ref.: Lisiewska & Tortić 1990, Škorić 1928 (1), unp. Tortić
Exs.: CNF

Mycena viridimarginata P. Karst.
Ref.: Tortić 1973, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

Mycena vitilis (Fr.) Quél.
Ref.: Focht 1972, Tortić & Lisiewska 1978, unp. Tortić

*_**Mycena vulgaris**_ (Pers. : Fr.) P. Kumm.
Ref.: unp. Tortić
Exs.: CNF

Mycena zephirus (Fr. : Fr.) P. Kumm.
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

Omphalina Quél.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1997, Clémençon 1982 a, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kreisel 1987, Singer 1986)

Omphalina epichysium (Pers. : Fr.) Quél.
= *Omphalia epichysium* (Pers. : Fr.) P. Kumm. (1)
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1989 b, unp. Tortić ( )(1)
Exs.: CNF

Omphalina griseopallida (Desm. : Fr.) Quél.
= *Leptoglossum griseopallidum* (Desm. : Fr.) Moser (comb. inval.)
= *Phaeotellus griseopallidus* (Desm. : Fr.) Kühner et Lamoure (comb. inval.)
Ref.: Focht 1974

Oudemansiella Speg.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Hansen & Knudsen 1992, Kreisel 1987, Watling & Turnbull 1998)

•***Oudemansiella mucida*** (Schrad. : Fr.) Höhn.
= *Armillaria mucida* (Schrad. : Fr.) P. Kumm. (1)
= *Lepiota mucida* (Schrad. : Fr.) ? (2)
= *Mucidula mucida* (Schrad. : Fr.) Pat. (3)
Ref.: Kranjčev 1979 (3), Kranjčev 1986 a, Lange 1974, Mužic & Božac 1997, Škorić 1928 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1979, Tortić 1989 b, Vouk & Pevalek 1915 (2), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić 1970, unp. Tortić ( )(3)
Exs.: BEO, CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

Panellus P. Karst.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Fries 1828, Fries 1836--1838, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Pilát 1935, Pilát 1951 b, Singer 1986, Watling & Turnbull 1998)

•***Panellus mitis*** (Pers. : Fr.) Singer
Ref.: Tortić 1973, Tortić 1989 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, PRM
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Turnbull 1998)

Panellus ringens (Fr. : Fr.) Romagn.
= *Lentinus ringens* (Fr. : Fr.) Fr. (1)
= *Panus ringens* (Fr. : Fr.) Fr. (2)
Ref.: Stoitzner 1869 (1), Tortić 1968 b, unp. Tortić ( )(2)

Panellus serotinus (Pers. : Fr.) Kühner
= *Hohenbuehelia serotina* (Pers. : Fr.) Singer (1)
= *Pleurotus serotinus* (Pers. : Fr.) P. Kumm. (2)
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 a, Tortić 1979, Tortić 1989 b, unp. Tortić ( )(1)(2)
Exs.: CNF

•***Panellus stipticus*** (Bull. : Fr.) P. Karst.
= *Agaricus stipticus* Bull. : Fr. (1)
= *Lentinus stipticus* (Bull. : Fr.) J. Schröt. (2)
= *Panus stipticus* (Bull. : Fr.) Fr. (3)
= *Panus semipetiolatus* (Schaeff.) Sacc. (4)
Ref.: Barčić 1989, Barčić 1996, Blagaić 1921 b (3), Jelić & Tortić 1973, Lisiewska & Tortić 1990, Lorinser - Janda 1877 (3), Moesz 1938 (4), Picbauer 1928 (3), Pilát 1925 (3), Schulzer 1882 a (3), Schulzer *& al.* 1866 (3), Škorić 1928 (2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1979, Tortić 1989 b, Tortić 1993, Tortić 1994, Tortić & Lisiewska 1978, Vouk & Pevalek 1915 (2), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(3), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Turnbull 1998)

•***Panellus violaceofulvus*** (Batsch : Fr.) Singer
Ref.: Tortić 1989 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Pleurocybella Singer

(Lit.: Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1989)

•***Pleurocybella porrigens*** (Pers. : Fr.) Singer
= *Agaricus porrigens* Pers. : Fr. (1)
= *Phyllotus porrigens* (Pers. : Fr.) P. Karst.
= *Pleurotellus porrigens* (Pers. : Fr.) Kühner et Romagn. (comb. inval.) (2)
= *Pleurotus porrigens* (Pers. : Fr.) P. Kumm. (3)
Ref.: Škorić 1928 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 a (2), Tortić 1989 b, Tortić 1994, unp. Tkalčec & Mešić, unp. Tortić ( )(3)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Watling & Gregory 1989)

Pseudoclitocybe (Singer) Singer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bollmann *& al.* 1996, Bon 1997, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Watling & Turnbull 1998)

•***Pseudoclitocybe cyathiformis*** (Bull. : Fr.) Singer
= *Agaricus cyathiformis* Bull. : Fr. (1)
= *Cantharellula cyathiformis* (Bull. : Fr.) Singer (2)
= *Clitocybe cyathiformis* (Bull. : Fr.) P. Kumm. (3)
Ref.: Focht 1974 (2), Gjurašin 1898 (3), Jelić & Tortić 1973, Škorić 1928 (1), Tortić 1964 (2), Tortić 1973, Tortić 1989 b, Vouk & Pevalek 1915 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(3), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Moser 1983, Watling & Turnbull 1998)

Pseudoclitocybe expallens (Pers. : Fr.) Moser
= *Agaricus expallens* Pers. : Fr. (1)
Ref.: Schulzer *& al.* 1866 (1)

Resupinatus Nees

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Domański 1964, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1989)

Resupinatus applicatus (Batsch : Fr.) Gray
= *Agaricus applicatus* Batsch : Fr. (1)
Ref.: Schulzer 1857 (1)
Exs.: CNF ?

Resupinatus vetlinianus (Domański) Moser
= *Pleurotus vetlinianus* Domański (1)
Ref.: Tortić 1989 a (1), unp. Tortić (1)
Exs.: CNF, PRM

Rickenella Raithelh.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1997, Clémençon 1982 a, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983)

•***Rickenella fibula*** (Bull. : Fr.) Raithelh.
= *Agaricus fibula* Bull. : Fr. (1)
= *Gerronema fibula* (Bull. : Fr.) Singer (2)
= *Mycena fibula* (Bull. : Fr.) Kühner (3)
= *Omphalia fibula* (Bull. : Fr.) P. Kumm. (4)
= *Omphalina fibula* (Bull. : Fr.) Quél.
Ref.: Focht 1974 (4), Jelić & Tortić 1973 (2), Lisiewska & Tortić 1990, Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1968 b (3), Tortić 1993,

Tortić & Lisiewska 1978 (2), Vouk & Pevalek 1915 (1), Vouk & Pevalek 1916 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić (3)
Exs.: CNF
(Lit.: Bon 1997, Clémençon 1982 a)

Ripartites P. Karst.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1995, Bon 1997, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986)

•***Ripartites tricholoma*** (Alb. et Schwein. : Fr.) P. Karst.
Ref.: Focht 1974, unp. Matočec, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1995, Moser 1983, Hansen & Knudsen 1992)

Strobilurus Singer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Turnbull 1998)

•***Strobilurus esculentus*** (Wulfen : Fr.) Singer
= *Pseudohiatula esculenta* (Wulfen : Fr.) Singer (1)
Ref.: Tortić 1973, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

*•***Strobilurus stephanocystis*** (Kühner et Romagn. ex Hora) Singer
Ref.: unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

•***Strobilurus tenacellus*** (Pers. : Fr.) Singer
= *Pseudohiatula tenacella* (Pers. : Fr.) Métrod (1)
Ref.: Focht 1972 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

Tricholoma (Fr.) Staude

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bon 1984 a, Bon 1984 b, Bon 1991, Breitenbach & Kränzlin 1991, Christensen & Noordeloos 1999, Dennis *& al.* 1960, Galli 1999, Hansen & Knudsen 1992, Konrad & Maublanc 1924-1937, Kreisel 1987, Kytövuori 1989, Moser 1983, Riva 1988, Singer 1986)

•***Tricholoma acerbum*** (Bull. : Fr.) Quél.
Ref.: Tortić 1964, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić

Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Riva 1988)

Tricholoma albobrunneum (Pers. : Fr.) P. Kumm. **sensu lato**
Incl.: *Tricholoma albobrunneum* (Pers. : Fr.) P. Kumm. (1)
Tricholoma batschii Gulden ex Mo. Chr. et Noordel.
= *Tricholoma subannulatum* (Batsch) Bres. (comb. illeg.) (2)
Tricholoma striatum (Schaeff.) Sacc.
= *Tricholoma albobrunneum* (Pers. : Fr.) P. Kumm. var. *striatum* (Schaeff.) ? (3)
Ref.: Barčić 1982 (1), Barčić 1996 (1), Focht 1972 (3), Focht 1974 (2), Focht 1979 (1), Tortić 1964 (1), unp. Tortić (1)
Exs.: CNF ?
Annotation: Modern authors disagree about interpretation and nomenclature of *Tricholoma albobrunneum* and *T. striatum* (see Arnolds *& al.* 1995, Christensen & Noordeloos 1999, Bon 1991, Hansen & Knudsen 1992, Kreisel 1987, Riva 1988). Focht (1974) considers *T. albobrunneum* a synonym of *T. subannulatum.*

Tricholoma album (Schaeff. : Fr.) P. Kumm.
Ref.: Barčić 1982, Barčić 1996, unp. Tortić

Tricholoma argyraceum (Bull.) P. Kumm.
= *Tricholoma inocybeoides* A. Pearson
Ref.: Focht 1983 b

Tricholoma atrosquamosum (Cheval.) Sacc.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Matočec, unp. Tortić
Exs.: CNF

•***Tricholoma aurantium*** (Schaeff. : Fr.) Ricken
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Galli 1999, Hansen & Knudsen 1992)

Tricholoma batschii Gulden ex Mo. Chr. et Noordel.
= *Tricholoma subannulatum* (Batsch) Bres. (comb. illeg.) non *T. subannulatum* (Peck) Zeller (1)
= *Tricholoma albobrunneum* (Pers. : Fr.) P. Kumm. var. *subannulatum* (Batsch) Lucand (2)
Misappl.: *Tricholoma fracticum* (Britzelm.) Kreisel sensu auct. non Britzelm. (3)
(sensu Britzelm. = nom. dub. - Christensen & Noordeloos 1999)
Ref.: Focht 1972 (2), Vrščaj 1990 (3), unp. Tortić (1)
Exs.: CNF

Tricholoma bresadolanum Clémençon
Ref.: Božac 1984, Božac 1986, Božac 1989, Božac 1993

•***Tricholoma bufonium*** (Pers. : Fr.) Gillet
= *Tricholoma sulphureum* (Bull. : Fr.) P. Kumm. var. *bufonium* (Pers. : Fr.) Quél. (1)
Ref.: Božac 1984, Focht 1979 (1), Tortić 1966 a, Tortić 1966 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Riva 1988)

•***Tricholoma caligatum*** (Viv.) Ricken
Ref.: Tortić 1973, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Kytövuori 1989, Riva 1988)

*•***Tricholoma cingulatum*** (Almfelt : Fr.) Jacobasch
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Hansen & Knudsen 1992, Riva 1988)

•***Tricholoma columbetta*** (Fr. : Fr.) P. Kumm.
Ref.: Focht 1979, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Hansen & Knudsen 1992, Riva 1988)

****Tricholoma coryphaeum*** (Fr.) Gillet
= *Tricholoma sejunctum* (Sowerby : Fr.) Quél. var. *coryphaeum* (Fr.) Konrad et Maubl. (1)
Ref.: unp. Lisiewska (1)
Exs.: POZM (1)

•***Tricholoma equestre*** (L. : Fr.) P. Kumm.
= *Tricholoma auratum* (Paulet) Gillet (1)
= *Agaricus flavovirens* Pers. : Fr. (2)
= *Tricholoma flavovirens* (Pers. : Fr.) S. Lundell et Nannf. (3)
Ref.: Božac 1989, Božac 1993, Focht 1979, Focht 1981 b (1)(3), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b (3), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (2)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983, Riva 1988)

•***Tricholoma fulvum*** (DC. : Fr.) Sacc.
= *Tricholoma flavobrunneum* (Fr.) P. Kumm. (1)
= *Tricholoma pseudonictitans* Bon
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 a (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Bon 1991, Moser 1983)

***Tricholoma imbricatum** (Fr. : Fr.) P. Kumm.
Ref.: unp. Tortić
Exs.: CNF

Tricholoma lascivum (Fr. : Fr.) Gillet
= *Agaricus lascivus* Fr. : Fr. (1)
Ref.: Tortić 1964, unp. Lisiewska, unp. Tortić, Vouk & Pevalek 1916 ? (1)
Exs.: CNF, POZM

•**Tricholoma luridum** (Schaeff. : Fr.) Quél.
= *Agaricus luridus* Schaeff. : Fr. (1)
Ref.: Vouk & Pevalek 1915 (1), Vouk & Pevalek 1916 (1), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Galli 1999)

Tricholoma myomyces (Pers. : Fr.) J.E. Lange
= *Agaricus myomyces* Pers. : Fr. (1)
Ref.: Schulzer *& al.* 1866 (1), Vrščaj 1990, Schulzer 1857 HR? (1)

•**Tricholoma orirubens** Quél.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bon 1991, Galli 1999)

•**Tricholoma pardinum** (Pers.) Quél.
= *Tricholoma pardalotum* Herink et Kotl.
Misappl.: *Tricholoma tigrinum* (Schaeff.) P. Kumm. sensu auct. non Schaeff. (1)
Ref.: Focht 1979 (1), Focht 1983 b (1), Tortić 1966 a, Tortić 1966 b, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983, Riva 1988)

Tricholoma populinum J.E. Lange
Ref.: Vrščaj 1990, unp. Tortić
Exs.: CNF

•**Tricholoma portentosum** (Fr. : Fr.) Quél.
Ref.: Barčić 1982, Barčić 1984, Barčić 1996, Focht 1979, Focht 1986, Tortić 1966 a, Tortić 1966 b, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Hansen & Knudsen 1992, Riva 1988)

Tricholoma psammopus (Kalchbr.) Quél.
= *Agaricus psammopus* Kalchbr. (1)
Ref.: Focht 1972, Fries 1874 HR? (1), Saccardo 1887 HR?

•***Tricholoma saponaceum*** (Fr. : Fr.) P. Kumm.
= *Agaricus saponaceus* Fr. : Fr. (1)
Ref.: Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec, unp. Tortić
Exs.: CNF, POZM

•var. ***saponaceum***
Ref.: unp. Tkalčec & Mešić
(Lit.: Bas *& al.* 1999, Bon 1991, Riva 1988)

*•var. ***boudieri*** Bigeard et H. Guill.
Misappl.: *Tricholoma saponaceum* (Fr. : Fr.) P. Kumm. var. *lavedanum* Rolland sensu auct. non Rolland
Ref.: unp. Tkalčec & Mešić
Exs. CNF
(Lit.: Bas *& al.* 1999, Bon 1991, Riva 1988)

*•var. ***squamosum*** (Cooke) Rea
Ref.: unp. Tkalčec & Mešić
Exs. CNF
(Lit.: Bas *& al.* 1999, Galli 1999)

•***Tricholoma scalpturatum*** (Fr.) Quél.
Ref.: Focht 1972, Focht 1979, Tortić 1964, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić, Focht 1986 HR?
Exs.: CNF
(Lit.: Bas *& al.* 1999, Bon 1991, Moser 1983)

•***Tricholoma sciodes*** (Pers.) C. Martin
Ref.: Tortić 1968 b, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Riva 1988)

•***Tricholoma sejunctum*** (Sowerby : Fr.) Quél.
= *Tricholoma viridilutescens* Moser
Ref.: Kišpatić 1950, Mužic & Božac 1984, Mužic & Božac 1997, Tortić 1964, Tortić & Lisiewska 1978, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Bon 1991, Galli 1999)

•***Tricholoma squarrulosum*** Bres.
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bon 1991, Galli 1999, Hansen & Knudsen 1992)

Tricholoma sudum (Fr.) Quél.
Ref.: Gjurašin 1898

•***Tricholoma sulphureum*** (Bull. : Fr.) P. Kumm.
= *Agaricus sulphureus* Bull. : Fr. (1)
Ref.: Barčić 1982, Barčić 1996, Focht 1979, Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, unp. Matočec, unp. Tortić
Exs.: BEO, CNF

•var. ***sulphureum***
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bon 1991)

*•var. ***coronarium*** (Pers.) Nüesch
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bon 1991)

Tricholoma terreum (Schaeff. : Fr.) P. Kumm.
= *Agaricus terreus* Schaeff. : Fr. (1)
Ref.: Barčić 1982, Barčić 1984, Barčić 1996, Božac 1989, Božac 1993, Focht 1972, Focht 1979, Focht 1981 b, Focht 1983 b, Focht 1986, Mužic & Božac 1984, Mužic & Božac 1997, Škorić 1928 (1), Tortić 1964, Tortić 1966 a, Vouk & Pevalek 1916 (1), unp. Matočec, unp. Tortić
Exs.: CNF

Tricholoma ustale (Fr. : Fr.) P. Kumm.
Ref.: Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: POZM

*•***Tricholoma vaccinum*** (Schaeff. : Fr.) P. Kumm.
Ref.: unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Galli 1999, Riva 1988)

Tricholomopsis Singer

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bon 1991, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Pilát 1951 b, Singer 1986)

•***Tricholomopsis decora*** (Fr. : Fr.) Singer
= *Pleurotus decorus* (Fr. : Fr.) Sacc. (1)
Ref.: Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1989 b, unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF, POZM
(Lit.: Bon 1991, Hansen & Knudsen 1992, Moser 1983)

•***Tricholomopsis rutilans*** (Schaeff. : Fr.) Singer
= *Pleurotus rutilans* (Schaeff. : Fr.) Pilát (1)
= *Tricholoma rutilans* (Schaeff. : Fr.) P. Kumm. (2)

Ref.: Kranjčev 1995, Lisiewska & Tortić 1990, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1989 b, Tortić 1994, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(1)(2)
Exs.: CNF
(Lit.: Bon 1991, Moser 1983)

Xeromphalia Kühner et Maire ("*Xeromphalina*")

(Lit.: Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Turnbull 1998)

•***Xeromphalia campanella*** (Batsch : Fr.) Kühner et Maire
Ref.: Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1989 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

Xeromphalia caulicinalis (Fr.) Kühner et Maire
= *Marasmius caulicinalis* Fr. (1)
Ref.: Vouk & Pevalek 1916 (1)

Xerula Maire

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bollmann *& al.* 1996, Breitenbach & Kränzlin 1991, Fries 1821, Hansen & Knudsen 1992, Kreisel 1987, Maas Geesteranus 1992 a, Moser 1983, Watling & Turnbull 1998)

*•***Xerula melanotricha*** Dörfelt
= *Oudemansiella melanotricha* (Dörfelt) Moser
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Breitenbach & Kränzlin 1991, Moser 1983)

•***Xerula pudens*** (Pers.) Singer
= *Agaricus longipes* Bull. (nom. illeg.) (1)
= *Collybia longipes* (Bull. →) Quél. (2)
= *Marasmius longipes* (Bull. → Quél.) Quél. (3)
= *Oudemansiella longipes* (Bull. → Quél.) Moser (4)
= *Xerula longipes* (Bull. → Quél.) Maire
Misappl.: *Oudemansiella badia* (Quél.) Moser (comb. inval.) sensu Moser non Quél. (5)
Ref.: Blagaić 1921 b (2), Gjurašin 1898 (2), Kišpatić 1950 (2), Lisiewska & Tortić 1990 (4), Schulzer 1882 a (1), Schulzer *& al.* 1866 (1), Tortić 1964 (4), Tortić 1966 a (5), Tortić 1966 b (5), Vouk & Pevalek 1915 (1), unp. Lisiewska (5), unp. Matočec (4), unp. Tkalčec & Mešić, unp. Tortić (3)
Exs.: CNF, POZM (5)
(Lit.: Bas *& al.* 1999, Breitenbach & Kränzlin 1991, Moser 1983)

Xerula pudens (Pers.) Singer sensu lato
= *Oudemansiella longipes* (Bull. → Quél.) Moser sensu lato (1)
Ref.: Tortić 1993, unp. Tortić (1)

•***Xerula radicata*** (Relhan : Fr.) Dörfelt
= *Agaricus radicatus* Relhan : Fr. (1)
= *Collybia radicata* (Relhan : Fr.) Quél. (2)
= *Oudemansiella radicata* (Relhan : Fr.) Singer (3)
= *Agaricus macrourus* Scop. (4)
= *Collybia macroura* (Scop.) ? (5)
= *Agaricus sudoroides* Schulzer (6)
Ref.: Barčić 1982 (3), Barčić 1996 (3), Blagaić 1921 b (5), Božac 1984 (3), Jelić & Tortić 1973 (3), Kišpatić 1950 (2), Lisiewska & Tortić 1990 (3), Schulzer 1880 a (6), Schulzer *& al.* 1866 (1), Škorić 1928 (4), Tortić 1964 (3), Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1989 b (3), Tortić 1993, Tortić & Lisiewska 1978 (3), Vouk & Pevalek 1915 (4), Vouk & Pevalek 1916 (4), unp. Matočec (3), unp. Tkalčec & Mešić, unp. Tortić (2)(3), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Turnbull 1998)

EXCLUDED RECORDS

Ordo **Agaricales** (family unknown to us)

Agaricus agrorum Schulzer - nom. nud.
= *Agaricus agricolus* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

Agaricus agrorum Schulzer var. ***coloratus*** Schulzer - nom. nud.
= *Agaricus agricolus* Schulzer var. *coloratus* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

Agaricus albicolor Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus amethysteoroseus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus anceps Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1877

Agaricus aureus Sowerby = **?**
Ref.: Schulzer 1857 HR?

Agaricus caesius Pers. = **?**
Ref.: Schulzer *& al.* 1866

Agaricus candidatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus capitatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus carneolamellatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus collabescens Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus collapsus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus collapsus Schulzer var. ***crateriformis*** Schulzer - nom. nud.
Ref.: Schulzer 1867 HR?

Agaricus congregatus Rabenh. = **?**
Ref.: Schulzer 1857 HR?

Agaricus cylindripes Schulzer - nom. nud.
Ref.: Schulzer 1867

Agaricus disciformis Wettst. = **?**
Ref.: Škorić 1928

Agaricus equinus Pers. = **?**
Ref.: Schulzer 1857 HR?

Agaricus eumorphus Pers. = **?**
Ref.: Schulzer *& al.* 1866 ?

Agaricus fertilis Pers. : Fr. = **?**
Ref.: Schulzer *& al.* 1866

Agaricus flavocinereus Pers. = **?**
Ref.: Schulzer 1857 HR?

Agaricus herpeticus Roques = **?**
Ref.: Schulzer *& al.* 1866

Agaricus hiemali-roraceus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus horticolus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus horticolus Schulzer var. ***glabropilus*** Schulzer - nom. nud.
Ref.: Schulzer 1867 HR?

Agaricus ilkae Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus incurvus Pers.
Ref.: Schulzer *& al.* 1866

Agaricus indigestus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus indigestus Schulzer var. ***juglandis*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus jucundus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus macer Schulzer - nom. nud.
Ref.: Schulzer 1867

Agaricus mastoideus Krombh. = **?**
Ref.: Schulzer *& al.* 1866, Schulzer 1857 HR?

Agaricus multicolor Pers. : Fr. = **?**
Ref.: Schulzer *& al.* 1866 ?

Agaricus nitens Schaeff. = **?**
Ref.: Schulzer *& al.* 1866, Schulzer 1857 HR?

Agaricus nitens Schaeff. var. ***albus*** (Schaeff.) ? = **?**
Ref.: Schulzer *& al.* 1866

Agaricus obscurans Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus ocellus Schulzer = **?** [*Pilosace*]
Ref.: Schulzer 1877

Agaricus pannosus Fr. : Fr. var. ***pascuus*** Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1877

Agaricus pannosus Fr. : Fr. var. ***rufisporus*** Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1877

Agaricus pratorum Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1878

Agaricus pygmaeoides Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1877

Agaricus roseolamellatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus segestrius Fr. : Fr. = **?**
Ref.: Schulzer *& al.* 1866 ?

Agaricus semiglobosus Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1879

Agaricus seriatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus spadochrous Krombh. = **?**
Ref.: Schulzer 1857 HR?

Agaricus subfissus Schulzer - nom. nud.
Ref.: Schulzer 1867 HR?

Agaricus subradicatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus subrugatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus subsalsus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus venustus Viv. = **?**
Ref.: Schulzer *& al.* 1866, Schulzer 1857 HR?

Agaricus vexans Schulzer var. ***robustior*** Schulzer = **?** [*Naucoria*]
Ref.: Schulzer 1881

Agaricus victorinae Schulzer - nom. nud.
Ref.: Schulzer 1867

Agaricus vindobonensis Tratt. = **?**
Ref.: Schulzer 1883 b HR?

Agaricus violaceus Pers. = **?**
Ref.: Schulzer 1857 HR?

Pilosace bresadolae Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

Familia **Pleurotaceae** Overeem ex Kühner et Romagn.

Agaricus farinodorus Schulzer = **?** [*Pleurotus*]
Ref.: Schulzer 1880 a

Agaricus squamatus Schulzer = **?** [*Pleurotus*]
Ref.: Schulzer 1882 b

Lentinus degener Kalchbr. var. ***elatus*** Schulzer = **?**
Ref.: Schulzer 1879

Lentinus degener Kalchbr. var. ***tomentosus*** Schulzer = **?**
Ref.: Schulzer 1879

Lentinus grateolens Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Lentinus leontopodius Schulzer var. ***insociabilis*** Schulzer = **?**
Ref.: Schulzer 1879

Lentinus leontopodius Schulzer var. ***silvaticus*** Schulzer = **?**
Ref.: Schulzer 1879

Panus cibaliensis Schulzer = **?**
Ref.: Schulzer 1879

Panus salignus (Pers. : Fr.) ? var. ***anciophyllos*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Panus solitarius Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Panus stipticoides Schulzer = **?**
Ref.: Schulzer 1879

Panus subinteger Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Familia **Tricholomataceae** R. Heim ex Pouzar

Agaricus alboflavus Schulzer = **?** [*Clitocybe*]
Ref.: Schulzer 1876

Agaricus alcalinus Fr. : Fr. - nom. dub. (Maas Geesteranus 1992 a)
Ref.: Stoitzner 1869, Vouk & Pevalek 1916

Agaricus amadelphoides Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1881

Agaricus amaricans Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1880 a, Schulzer *& al.* 1866

Agaricus amicoides Schulzer = **?** [*Tricholoma*]
Ref.: Schulzer 1880 a

Agaricus androsaceus "Pers." = **?**
Ref.: Schulzer 1857 HR?

Agaricus bellus Pers. : Fr. = **?** [*Clitocybe*]
Ref.: Vouk & Pevalek 1916

Agaricus brumalis Fr. : Fr. var. ***slavonicus*** Schulz. = **?**
Ref.: Schulzer 1878

Agaricus candiculus Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1878, Schulzer *& al.* 1866 (nom. nud.)

Agaricus candiculus Schulzer var. ***hortensis*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus contortus Bull. : Fr. - nom. dub. (Antonín & Noordeloos 1997)
Ref.: Schulzer *& al.* 1866

Agaricus corticola Pers. : Fr. - nom. ambig. (Maas Geesteranus 1992 a)
Ref.: Vouk & Pevalek 1915, Schulzer 1857 HR?

Agaricus derodus Schulzer = **?** [*Armillaria*]
Ref.: Schulzer 1878

Agaricus deumbonatus Schulzer = **?** [*Tricholoma*]
Ref.: Schulzer 1881

Agaricus diaphanus Schulzer - nom. dub. (Maas Geesteranus 1992 a)
= *Mycena nivea* Quél. et Schulzer (nom. illeg.) (1)
Ref.: Schulzer 1879, Schulzer 1885 (1), Saccardo 1887 HR? (1)

Agaricus electus Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1878

Agaricus electus Schulzer var. ***autumnalis*** Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1879

Agaricus electus Schulzer var. ***subumbonatus*** Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1878

Agaricus elevatus Weinm. - nom. dub. (Antonín & Noordeloos 1997)
Ref.: Vouk & Pevalek 1916

Agaricus erythropus Pers. : Fr. var. ***slavonica*** Schulzer = **?** (*Collybia*)
Ref.: Schulzer 1880 a

Agaricus galericulatus Scop. : Fr. var. "**b. amoene albus**" Fr. 1821 = **?**
Ref.: Schulzer 1857 HR?

Agaricus gracillimus Weinm.
Ref.: Vouk & Pevalek 1916

Annotation: According to Dennis *& al.* (1960) this species is doubtful in the original, Weinmann's sense. Bresadola and J. E. Lange have misapplied this name to *Hemimycena delectabilis* (Peck) Singer (Bollmann *& al.* 1996, Dennis *& al.* 1960). We do not know in which sense the author of the record has used this name.

Agaricus humicola Schulzer = **?** [*Clitocybe*]
Ref.: Schulzer 1878

Agaricus insignis Schulzer = **?** [*Clitocybe*]
= *Hygrophorus insignis* Schulzer (1)
Ref.: Schulzer 1876 (1), Schulzer 1880 a

Agaricus intornatus Schulzer = **?** [*Clitocybe*]
Ref.: Schulzer 1880 a

Agaricus lineatus Bull. : Fr. - nom. dub. (Maas Geesteranus 1992 a)
Ref.: Vouk & Pevalek 1915

Agaricus longipes Bull. var. ***inornatus*** Schulzer = **?**
Ref.: Schulzer 1878

Agaricus melleus Vahl : Fr. var. ***sciacephalus*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus obliquus Pers. : Fr. var. ***slavonicus*** Schulzer = **?** [*Clitocybe*]
Ref.: Schulzer 1878

Agaricus oniscoides Schulzer = **?** [*Omphalia*]
Ref.: Schulzer 1878

Agaricus personatus Fr. : Fr.
Ref.: Schulzer *& al.* 1866
Annotation: *Agaricus personatus* is a synonym of *Lepista nuda* (Bull. : Fr.) Cooke (Dennis *& al.* 1960). However, since many authors have misapplied this epithet for *L. saeva* (Fr.) P.D. Orton, we do not know in which sense the author of the record has used this name.

Agaricus platyphylloides Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1878

Agaricus platyphyllus Pers. : Fr. var. ***rhizomatus*** Schulzer = **?**
Ref.: Schulzer *& al.* 1866

Agaricus platyrhizus Schulzer = **?** [*Collybia*]
= *Tricholoma fallaciosum* Sacc. (nom. illeg.) (1)
= *Tricholoma fallax* Quél. et Schulzer (nom. illeg.) (2)
Ref.: Saccardo 1887 (1), Schulzer 1878, Schulzer 1885 (2)

Agaricus radicatus Relhan : Fr. var. ***luteolamellatus*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus radiculiferus Schulzer = **?** [*Collybia*]
Ref.: Schulzer 1881

Agaricus sejunctus Sowerby : Fr. var. ***sapidus*** Schulzer = **?**
Ref.: Schulzer 1878

Agaricus sulphureus Bull. : Fr. var. ***inflatipes*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus tardissimus Schulzer = **?** [*Omphalia*]
Ref.: Schulzer 1867 (nom. nud.), Schulzer 1878

Agaricus tardissimus Schulzer var. ***aciphilus*** Schulzer - nom. nud.
Ref.: Schulzer 1867

Agaricus tumidoideus Schulzer = **?** [*Tricholoma*]
Ref.: Schulzer 1879

Agaricus viticola Schulzer - nom. dub. (Maas Geesteranus 1992 a)
= *Mycena bresadolae* Schulzer (nom. illeg.) (1)
Ref.: Schulzer 1867 (nom. nud.), Schulzer 1878, Schulzer 1885 (1), Saccardo 1887 HR?

Calocybe graveolens (Pers. : Fr.) Singer
= *Agaricus graveolens* Pers. : Fr. (1)
= *Tricholoma georgii* (Clus. ex L.) Quél. var. *graveolens* (Pers. : Fr.) ? (2)
Ref.: Blagaić 1923 (2), Vouk & Pevalek 1916 (1)
Annotation: Singer (1977, 1986) considers it an autonomous species, while Dennis *& al.* (1960) and Kreisel (1987) regard it a synonym of *Calocybe gambosa* (Fr. : Fr.) Singer ex Donk. If these two species are conspecific, the epithet *graveolens* has priority.

Chaetocalathus craterellus (Durieu et Lév.) Singer
Ref.: Antonín & Noordeloos 1997
Exs.: FH
Annotation: The author of the record specified that the locality (Zelenika near Castelnuovo) belongs to Croatia, but presently the locality belongs to Montenegro (Yugoslavia).

Clitocybe bresadolae Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

Clitocybe brumalis (Fr. : Fr.) P. Kumm.
Ref.: Focht 1972
Annotation: This species is interpreted in a few different senses (see Clémençon 1984 a, Kuyper 1996). We do not know in which sense the author of the record has used this name.

Clitocybe dealbata (Sowerby : Fr.) P. Kumm. - nom. dub. (Bas *& al.* 1995)
= *Agaricus dealbatus* Sowerby : Fr. (1)
Ref.: Barčić 1982, Barčić 1996, Božac 1982, Focht 1986, Vouk & Pevalek 1915 (1)
Annotation: According to Arnolds *& al.* (1995) and Bas *& al.* (1995) this epithet has been misapplied for *Clitocybe rivulosa* (Pers. : Fr.) P. Kumm. and *C. augeana* (Mont.) Sacc. Since we do not know in which sense the author of the record has used this name, we exclude it.

Clitocybe jandae Schulzer = **?**
Ref.: Schulzer 1887

Clitocybe laccata (Scop. : Fr.) P. Kumm. var. ***rufocarnea*** (Fr.) ? = **?**
Ref.: Blagaić 1921 b

Clitocybe maxima (Gärtn. et G. Mey.) P. Kumm.
Ref.: unp. Matočec, unp. Tortić
Exs.: CNF
Annotation: Bas *& al.* (1995) and Kuyper (1996) consider it a nomen dubium, and that records of this species in fact represent *Clitocybe geotropa* (DC. et Lam.) Quél., *C. gigas* Harmaja or *Leucopaxillus giganteus* (Sibth. : Fr.) Singer. Without revision it is not possible to know which species the authors of the records for Croatia have found.

Collybia accommodans (Schulzer) Sacc.
= *Agaricus accommodans* Schulzer (1)
Ref.: Saccardo 1887, Schulzer 1882 a (1)
Annotation: Antonín & Noordeloos (1997) consider that it could well be identical with *Micromphale brassicolens* (Romagn.) P.D. Orton.

Collybia dryophila (Bull. : Fr.) P. Kumm. var. ***minor*** Bres.
= *Agaricus radiculans* Schulzer (1)
Ref.: Saccardo 1887, Schulzer 1878 (1), Schulzer 1885
Annotation: Antonín & Noordeloos (1997) consider that it could be a form of *Collybia dryophila* (Bull. : Fr.) P. Kumm.

Collybia dryophila (Bull. : Fr.) P. Kumm. var. ***peronata*** Bres. - nom. dub. (Antonín & Noordeloos 1997)
= *Agaricus peronatoides* Schulzer (1)
Ref.: Schulzer 1880 a (1), Schulzer 1885, Saccardo 1887 HR?

Collybia dryophila (Bull. : Fr.) P. Kumm. var. ***vernalis*** (Schulzer) Schulzer et Bres.
= *Agaricus vernalis* Schulzer (1)
Ref.: Schulzer 1880 a (1), Schulzer 1885, Saccardo 1887 HR?
Annotation: Antonín & Noordeloos (1997) consider it a nomen dubium; it could represent *Collybia nivalis* (Luthi et Plomb) Moser.

Collybia rigidipes (Schulzer) Sacc. - nom. dub. (Antonín & Noordeloos 1997)
= *Agaricus rigidipes* Schulzer (1)
Ref.: Saccardo 1887, Schulzer 1882 a (1)

Collybia spuria (Bres.) Sacc. = **?**
= *Collybia platyphylla* (Pers. : Fr.) P. Kumm. var. *spuria* Bres. (1)
Ref.: Saccardo 1887, Schulzer 1885 (1)

Cyphella erosa Schulzer = **?**
Ref.: Schulzer 1874

Marasmius aggericola Schulzer - nom. nud.
= *Marasmius depressus* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

Marasmius amoenipes Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius angulatus (Batsch) Berk. et Broome
Ref.: Vouk & Pevalek 1915
Annotation: Batsch's epithet *angulatus* refers to *Psilocybe angulata* (Batsch) Singer (Singer 1986). The combination *Marasmius angulatus* suggests misinterpretation of this species, so we do not know which species the authors of the record for Croatia have found.

Marasmius auripes Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius avellanae Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius brusinae Schulzer - nom. dub. (Antonín & Noordeloos 1993)
Ref.: Saccardo 1887, Schulzer 1886

Marasmius calopus (Pers. : Fr.) Fr. - nom. dub. (Antonín & Noordeloos 1993)
Ref.: Schulzer *& al.* 1866

Marasmius catharinae Schulzer - nom. nud.
= *Marasmius stellatus* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

Marasmius corticola (Pers. : Fr.) Schulzer var. ***albidus*** (Fr. : Fr.) Schulzer - nom. ambig. (Maas Geesteranus 1992 a)
Ref.: Schulzer *& al.* 1866

Marasmius corticola (Pers. : Fr.) Schulzer var. ***fuscescens*** (Fr. : Fr.) Schulzer - nom. ambig. (Maas Geesteranus 1992 a)
Ref.: Schulzer *& al.* 1866

Marasmius corticola (Pers. : Fr.) Schulzer var. ***filipes*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius declinatus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866 + Schulzer 1867

Marasmius filopes (Bull. : Fr.) Schulzer var. ***marcescens*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius galericulatus (Scop. : Fr.) Schulzer var. ***transiens*** Schulzer - nom. nud.
Ref.: Schulzer 1867 HR?

Marasmius leucoumbrinus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius molyoides Fr. - nom. dub. (Antonín & Noordeloos 1993)
Ref.: Vouk & Pevalek 1916

Marasmius olens Schulzer - nom. nud.
= *Marasmius teneripes* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

Marasmius peronatus (Bolton : Fr.) Fr. var. ***rugulosus*** (Schulzer) Schulzer et Bres. - nom. dub. (Antonín & Noordeloos 1997)
= *Agaricus peronatus* Bolton : Fr. var. *rugulosus* Schulzer (1)
Ref.: Schulzer 1880 a (1), Schulzer 1885, Saccardo 1887 HR?

Marasmius praticolus Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Marasmius queletii Schulzer = ?
= *Agaricus oreades* Bolton : Fr. var. *albidus* Schulzer (1)
Ref.: Schulzer 1879 (1), Schulzer 1885, Saccardo 1887 HR?

Marasmius schulzeri Quél. = ?
= *Agaricus androsaceus* "Pers." var. *truncicola* Schulzer (1)
Ref.: Schulzer 1880 a (1), Schulzer 1885, Saccardo 1887 HR?

Marasmius tinctipes Schulzer - nom. nud.
- as *Marasmius androsaceus* (L. : Fr.) Fr. (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

Marasmius vukotinovicianus Schulzer
Ref.: Schulzer 1887
Annotation: Antonín & Noordeloos (1997) consider it a nomen dubium; it could be identical with *Marasmius cohaerens* (Pers. : Fr.) Cooke et Quél.

Melanoleuca subbrevipes Métrod ex Bon
Ref.: Božac 1984
Annotation: Recent authors interpret this species in different ways. Some authors consider it a synonym of *Melanoleuca grammopodia* (Bull. : Fr.) Pat. (Arnolds *& al.* 1995, Bas *& al.* 1999, Kreisel 1987, Watling & Turnbull 1998), while others consider it an autonomous species (Bon 1991, Hansen & Knudsen 1992, Singer 1986).

Mycena arborea (Schulzer) Sacc. - nom. dub. (Maas Geesteranus 1992 a)
= *Agaricus arboreus* Schulzer (1)
Ref.: Saccardo 1887, Schulzer 1882 a (1)

Mycena corticola (Pers. : Fr.) Gray - nom. ambig. (Maas Geesteranus 1992 a)
Ref.: Jaap 1916, unp. Tortić
Exs.: CNF

Mycena debilis (Fr.) Quél. - nom. dub. (Maas Geesteranus 1992 a)
Ref.: Jaap 1916

Mycena stannea (Fr.) Quél. - nom. dub. (Maas Geesteranus 1992 a)
Ref.: Gjurašin 1898

Mycena tintinnabulum (Fr.) Quél.
Ref.: Tortić 1968 b ?
Exs.: CNF
Annotation: The author himself doubted his identification.

Mycena viscidolutea (Schulzer) Sacc. - nom. dub. (Maas Geesteranus 1992 a)
= *Agaricus viscidoluteus* Schulzer (1)
Ref.: Saccardo 1887, Schulzer 1882 a (1)

Omphalia scyphiformis (Fr.) Gillet
Ref.: Gjurašin 1898
Annotation: Dennis *& al.* (1960) consider it an autonomous species (*Omphalina scyphiformis* (Fr.) Quél.), but according to them a modern

description is needed. We exclude the record since the species has not been mentioned in more recent literature available to us.

Panus craterellus (Durieu et Lév.) ?
Ref.: Kalchbrenner & Schulzer 1873-1877 HR?
Annotation: According to Pilát (1935), Kalchbrenner & Schulzer (1873-1877) misapplied this epithet, probably for *Pleurotus* (today *Panellus*) *violaceofulvus* (Batsch : Fr.) Pilát f. *delastrei* (Mont.) Malk.

Paxillus laetipes Schulzer = **?** [*Lepista*]
Ref.: Schulzer 1876

Paxillus laetipes Schulzer var. ***coprophilus*** Schulzer = **?** [*Lepista*]
Ref.: Schulzer 1879

Pseudohiatula conigena (Pers. : Fr.) Moser - nom. ambig. (Dennis *& al.* 1960, Singer 1986, Watling & Turnbull 1998)
Ref.: Focht 1972

Tricholoma amethystinum "Fr." = **?**
Ref.: Gjurašin 1898

Tricholoma bresadolae Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

Tricholoma resplendens (Fr.) Quél.
Ref.: Gjurašin 1898
Annotation: This species is interpreted in a few different senses (see Bon 1984 b, Dennis *& al.* 1960, Kreisel 1987). We do not know in which sense the author of the record has used this name.

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THAXTEROGASTER IS A TAXONOMIC SYNONYM OF CORTINARIUS: NEW COMBINATIONS AND NEW NAMES

Ursula Peintner[1,2], Meinhard Moser[2] and Rytas Vilgalys[1]

[1]Institute of Biology, Duke University, Durham, NC 27709, USA
[2]Institute of Microbiology, University of Innsbruck, Technikerstr. 25,
6020 Innsbruck, Austria
ursula.peintner@uibk.ac.at

Abstract

Results of our earlier molecular phylogenetic studies using sequences of the rDNA internal transcribed spacers (ITS) showed that the genus *Thaxterogaster* is polyphyletic, and nested within *Cortinarius*: the secotioid *Thaxterogaster* spp. have multiple origins within the subgenera *Myxacium, Phlegmacium* and *Telamonia*. In order to acknowledge these phylogenetic relationships, and the given morphological transitions, we propose to synonymize *Thaxterogaster* with *Cortinarius*. For the 54 currently recognized species of *Thaxterogaster* as well as for 2 varieties, 41 new combinations and 15 new names are proposed.

Key words: Sequestrate Agaricales, Cortinariaceae, nomenclature.

Introduction

The genus *Thaxterogaster* Singer (1951) had been erected to accommodate taxa with *Cortinarius*-like spores, but with basidiomes characterized by a reduced stipe and a basally exposed hymenium with a loculate to lamellate gleba (secotioid basidiomes). The type species is *Thaxterogaster magellanicum* Singer. In the following years, many new *Thaxterogaster* spp. have been described (Singer, 1960; Singer and Smith, 1958, 1963; Moser 1964; Horak and Moser, 1965; Thiers and Smith, 1969; Horak, 1973a, 1979; Halling, 1981; Beaton et al., 1985; Calhoun, 1989; Bougher, 1997; Soop, 1998; Trappe and Castellano, 2000).

However, already Moser (1964) as well as Horak and Moser (1965) noticed that *Thaxterogaster* and *Cortinarius* (Pers.) S.F. Gray are not only very closely related, but that transitions between the respective basidiome morphologies occur, sometimes even between basidiomes of one collection. They regarded *Thaxterogaster* as polyphyletic because of the existence of links between species, or groups of species of *Thaxterogaster* and different subgenera of *Cortinarius*. Also the distinctive character of *Thaxterogaster* spp., namely "lack of active spore discharge", was observed to be highly variable: the axial spore symmetry can be completely lacking in several *Thaxterogaster* species. Thus, the delimitation of *Thaxterogaster* and *Cortinarius* was mainly based on the presence of a loculate hymenium, and transitions between *Cortinarius* and *Thaxterogaster* are obvious (Horak and Moser, 1965). Therefore, Horak and Moser (1965) conclude that if *Cortinarius* is monophyletic, *Thaxterogaster* is probably polyphyletic.

Although the affinities between *Cortinarius* and *Thaxterogaster* were soon recognized, the direction of morphological evolution has long been debated (Smith, 1971; Singer, 1975; Thiers, 1984). However, recent molecular phylogenetic studies (Peintner et al., 2001), using sequences of the rDNA internal transcribed spacers (ITS) showed that the reduced basidiome types of *Thaxterogaster* spp. derived several times from agaric-like *Cortinarius* precursors. Moreover, the genus *Thaxterogaster* is polyphyletic and nested within the *Cortinarius* clade: species currently classified in the genus *Thaxterogaster* have multiple origins within the subgenera *Myxacium, Phlegmacium* and *Telamonia*. In order to acknowledge these phylogenetic relationships, and the given morphological transitions between these genera, we propose to synonymize *Thaxterogaster* with *Cortinarius*.

Regarding the nomenclature of *Thaxterogaster*, controversy exists about the gender of this genus name: specific epithets were applied in the neuter gender (-um) in most basionyms, but later corrected to masculine (-us). Currently, most generic names derived from "gaster" (e.g. *Thaxterogaster, Phallogaster, Hymenogaster*) are used as masculine names. However, the gender of the Greek word "gaster" (stomach) is feminine. Thus, following the St. Louis code of botanical nomenclature (Greuter et. al, 2000), all generic names derived from "gaster" should be regarded as feminine. Because epithets should agree grammatically with the generic name, they are to be corrected (Art 23.5, or 32.5, or 60.1). No such corrections have been made in this paper.

Correct names, new names and proposed combinations

Cortinarius albocanus (E. Horak & M.M. Moser) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster albocanum* E. Horak & M.M. Moser 1965, Nova Hedwigia X, 234; ut *Thaxterogaster albocanus.*

Cortinarius anisodorus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster anisodorum* E. Horak 1973, Beih. Nova Hedwigia 43:107; ut *Thaxterogaster anisodorus.*

Cortinarius archeuretus (Halling) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster archeuretus* Halling 1981, Mycologia 73: 861.

Cortinarius basipurpureus (Bougher) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster basipurpureum* Bougher 1997, Mycotaxon 63:43-45.

Cortinarius brachyspermus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster brevisporum* Singer 1960, Persoonia 1:386. non *Cortinarius brevisporus* M.M. Moser 1975.

Cortinarius cabrinii (Raithelh.) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster cabrinii* Raithelh. 1983, Metrodiana, Sonderheft 2:20.

Cortinarius campbellae (Berk. & Broome ex Zeller & C. W. Dodge) Peintner & M.M. Moser comb. nov. Basionym: *Arcangeliella campbellae* Berk. & Broome ex Zeller & C. W. Dodge 1935, Ann. Missouri. Bot. Garden 22:366. Synonym: *Thaxterogaster campbellae* (Zeller & C. W. Dodge) G.W. Beaton, Pegler & T. W. K. Young 1985, Kew Bulletin 40: 173. *Hymenogaster campbelli* Berkeley & Broome, herb. nom.

Cortinarius carneoroseus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster carneoroseum* E. Horak 1965, Nova Hedwigia X, 229; ut *Thaxterogaster carneoroseus.*

Cortinarius cartilagineus (G. Cunn.) Peintner & M.M. Moser comb. nov. Basionym: *Secotium cartilagineum* G. Cunn. 1924, Proc. Linn. Soc. New South Wales 49:115. Synonym: *Thaxterogaster cartilagineus* (G. Cunn.) M.M. Moser 1965, in E. Horak & M.M. Moser 1965, Nova Hedwigia X, 228.

Cortinarius conei (R. Heim) Peintner & M.M. Moser comb. nov. Basionym: *Secotium conei* R. Heim 1951, Rev. de Myc. 16: 142. Synonym: *Thaxterogaster conei* (R. Heim) E. Horak & M.M. Moser 1965, Nova Hedwigia X: 239.

Cortinarius conoides Peintner & M.M. Moser nom. nov. Basionym: *Secotium conicum* Hesler 1933, Jour. Elisha Mitchell Soc. 49:153. Synonym: *Thaxterogaster conicum* (Hesler) Singer & A. H. Sm. 1958, Brittonia 10:214. ut *Thaxterogaster conicus.* non *Cortinarius conicus* (Velen.) Rob. Henry 1941.

Cortinarius cretaceus (E. Horak) E. Horak (1980) [1979], Fl. criptog. Tierra del Fuego (Buenos Aires) 11(6):464. Basionym: *Thaxterogaster cretaceum* E. Horak 1965, Nova Hedwigia 10: 236; ut *Thaxterogaster cretaceus.*

Cortinarius cunninghamii (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster cunninghamii* E. Horak 1973, Beih. Nova Hedwigia 43: 92. Missapplied name: *Secotium leucocephalum* auct. non Massee in Cleland 1934-1935, in Toadst. Mush.South Australia:291.

Cortinarius daucodes Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster subulatum* E. Horak 1965, Nova Hedwigia X, 233. non *Cortinarius subulatus* (Rob. Henry) Bidaud, Moënne-Loccoz & Reumaux 1997.

Cortinarius dibaphoides (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster dibaphoides* E. Horak 1979 (1980), Flora Criptogamica Tierra del Fuego (Buenos Aires) 11(6):33.

Cortinarius dombeyi (Singer) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster dombeyi* Singer 1960, Persoonia 1:385.

Cortinarius epiphaeus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster epiphaeum* E. Horak 1973, Beih. Nova Hedwigia 43:100; ut *Thaxterogaster epiphaeus.*

Cortinarius flavidulus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster luteolum* E. Horak 1973, Beih. Nova Hedwigia 43:105; ut *Thaxterogaster luteolus.* non *Cortinarius luteolus* M.M. Moser 1975.

Cortinarius flavovelus (Grgurinovic) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster flavovelus* Grgurinovic 1997, Larger Fungi of South Australia:101. Missapplied name: *Secotium ochraceum* auct. non Rodway in Cleland 1934-1935, in Toadst. Mush. South Australia:289.

See Errata

Cortinarius fragilis (Zeller & C. W. Dodge) Peintner & M.M. Moser comb. nov. Basionym: *Hymenogaster fragilis* Zeller & C. W. Dodge in C. W. Dodge & Zeller 1934, Ann. Miss. Bot. Gard. 21:646. Synonym: *Thaxterogaster fragile* (Zeller & C. W. Dodge) A. H. Sm. & Singer 1963 in Singer and Smith, Madroño 17: 25; ut *Thaxterogaster fragilis,* ut *Thaxterogaster fragilis* var. *fragilis.*

Cortinarius fragilis var. *cortinariopsis* (Singer) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster fragile* var. *cortinariopsis* Singer 1969, Beihefte zur Nova Hedwigia 29: 364.

Cortinarius fuegianus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster magellanicum* Singer 1951, Mycologia 43:219. non *Cortinarius magellanicus* Speg. 1887.

Cortinarius glutinopallens (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster glutinopallens* E. Horak 1965, Nova Hedwigia X, 220.

Cortinarius holojanthinus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster violaceum* Singer 1951, Mycologia 43:216, ut *Thaxterogaster violaceus var. violaceus.* non *Cortinarius violaceus* (L. : Fr.) Fr. 1838.

Cortinarius holojanthinus var. *citrisporus* Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster violaceum var. citrisporum* M.M. Moser 1965, Nova Hedwigia X, 223.

Cortinarius hygrophilus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster bibulum* Singer 1969, Beihefte zur Nova Hedwigia 29: 361; ut *Thaxterogaster bibulus.* non *Cortinarius bibulus* Quél. 1881.

Cortinarius janthinocaulis Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster violeipes* M.M. Moser 1965, Nova Hedwigia X, 230. non *Cortinarius violeipes* M.M. Moser in M.M. Moser & E. Horak 1975.

Cortinarius leucocephalus (Massee) Peintner & M.M. Moser comb. nov. Basionym: *Secotium leucocephalum* Massee 1891, Grevillea 19:95.; Synonym: *Thaxterogaster leucocephalum* (Massee) Singer & A. H. Sm. 1958, Brittonia 10:210; ut *Thaxterogaster leucocephalus.*

Cortinarius levisporus (Massee & Rodway) Peintner & M.M. Moser comb. nov. Basionym: *Hymenogaster levisporus* Massee & Rodway in Rodway 1912, Pap. Proc. Roy. Soc. Tasm. 1911:30. Synonyms: *Thaxterogaster levisporus* (Rodway) G.W. Beaton, Pegler & T. W. K. Young 1985, Kew Bulletin 40: 172. *Hymenogaster maideni* Rodway 1921, Pap. Proc. Roy. Soc. Tasm. 1920:157. *Octaviana levispora* Rodway 1924, Pap. Proc. Roy. Soc. Tasm. 1923:157.

Cortinarius lubricus (M.M. Moser) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster lubricum* M.M. Moser 1965, Nova Hedwigia X, 226.

Cortinarius luteirufescens (Bougher) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster luteirufescens* Bougher 1997, Mycotaxon 63:44-47.

Cortinarius luteobrunneus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster leoninum* E. Horak 1973, Beih. Nova Hedwigia 43:98; ut *Thaxterogaster leoninus.* non *Cortinarius leoninus* Velen. 1922.

Cortinarius luteocarnosus (Raithelh.) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster luteocarnosum* Raithelh. (1983) Metrodiana, Sonderheft 2:21; ut *Thaxterogaster luteocarnosus.*

Cortinarius mustella (M.M. Moser) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster mustella* M.M. Moser 1965, Nova Hedwigia X, 227.

Cortinarius napivelatus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster napivelatum* E. Horak 1973, Beih. Nova Hedwigia 43:110; ut *Thaxterogaster napivelatus.*

Cortinarius nivalis (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster nivale* E. Horak 1973, Beih. Nova Hedwigia 43:89; ut *Thaxterogaster nivalis.*

Cortinarius nothofagi (E. Horak) E. Horak (1980) [1979], Fl. criptog. Tierra del Fuego (Buenos Aires) 11(6): 452. Basionym: *Thaxterogaster nothofagi* E. Horak 1965, Nova Hedwigia X, 238.

Cortinarius ochraceoazureus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster ochraceoazureum* E. Horak 1965, Nova Hedwigia X, 237. Synonyms: *Rozites ochraceoazurea* (E. Horak) E. Horak (1980); *Cortinarius ochrojanthinus* E. Horak & M.M. Moser in M.M. Moser & E. Horak 1975: Nova Hedwigia, Beih. 52: 274; *Cortinarius gliocyclus* E. Horak in Moser & Horak 1975: Nova Hedwigia, Beih. 52: 275.

Cortinarius ohauensis (Soop) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster ohauensis* Soop 1998, Documents Mycologiques 18 (112):20.

Cortinarius olorinus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster olorinum* E. Horak 1965, Nova Hedwigia X, 218; ut *Thaxterogaster olorinus.*

Cortinarius orphinus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster brunneus* G. W. Beaton, Pegler & T. W. K. Young 1985, Kew Bulletin 40(1): 174. non *Cortinarius brunneus* (Pers. : Fr.) Fr. 1838.

Cortinarius paveleckii (Trappe, Castellano & P. Rawlinson) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster paveleckii* Trappe, Castellano & P. Rawlinson 2000, Mycotaxon 75:174-176.

Cortinarius peraurantiacus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster aurantiacum* E. Horak 1973, Beih. Nova Hedwigia 43:104. non *Cortinarius aurantiacus* M.M. Moser 1951.

Cortinarius pingue (Zeller) Peintner & M.M. Moser comb. nov. Basionym: *Secotium pingue* Zeller 1941, Mycologia 33:211. Synonym: *Thaxterogaster pingue* (Zeller) Singer & A. H. Sm. 1958, Brittonia 10:211; ut *Thaxterogaster pinguis.*

Cortinarius piriforme (Cleland & G. Cunn.) Peintner & M.M. Moser comb. nov. Basionym: *Secotium piriforme* Cleland & G. Cunn. 1924, Proc. Linn. Soc. New South Wales 49:115, pl. 15/3. Synonym: *Thaxterogaster piriforme* (Cleland & G. Cunn.) M.M. Moser 1965, Nova Hedwigia 10: 223; ut *Thaxterogaster piriformis.*

Cortinarius pisciodorus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster pisciodorum* E. Horak 1973, Beih. Nova Hedwigia 43:97; ut *Thaxterogaster pisciodorus.*

Cortinarius porphyroideus Peintner & M.M. Moser nom. nov. Basionym: *Secotium porphyreum* G. Cunn. 1924, Proc. Linn. Soc. New South Wales 49:114. Synonym: *Thaxterogaster porphyreum* (G. Cunn.) Singer 1958, Brittonia 10:212. ut *Thaxterogaster porphyreus*. non *Cortinarius porphyreus* E. Horak 1975, in M.M. Moser & E. Horak 1975.

Cortinarius redactus (G. W. Beaton, Pegler & T. W. K. Young) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster redactus* G.W. Beaton, Pegler & T. W. K. Young 1985, Kew Bulletin 40(1):177.

Cortinarius sarcinochrous Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster carneolum* E. Horak 1973, Beih. Nova Hedwigia 43:102; ut *Thaxterogaster carneolus*. non *Cortinarius carneolus* M.M. Moser & E. Horak 1975.

Cortinarius scabrosus (Cooke & Massee) Peintner & M.M. Moser comb. nov. Basionym: *Secotium scabrosum* Cooke & Massee 1891, Grevillea 20:35. Synonym: *Thaxterogaster scabrosum* (Cooke & Massee) A. H. Sm. & Singer 1963, in Singer and A. H. Sm. Madroño 17:23; ut *Thaxterogaster scabrosus*.

Cortinarius sclerosperma Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster verrucisporum* E. Horak 1965, Nova Hedwigia X, 226. non *Cortinarius verrucisporus* Thiers & A. H. Sm. 1969.

Cortinarius sphaerocephalus (E. Horak & M.M. Moser) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster sphaerocephalum* E. Horak & M.M. Moser 1965, Nova Hedwigia X, 232; ut *Thaxterogaster sphaerocephalus*.

Cortinarius squamatus (Halling) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster squamatus* Halling 1981, Mycologia 73: 863; ut *Thaxterogaster squamatum*.

Cortinarius subalbidus (A. H. Sm.) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster subalbidum* A. H. Sm. 1963, in Singer and Smith 1963, Madroño 17: 24; ut *Thaxterogaster subalbidus*.

Cortinarius thiersianus Peintner & M.M. Moser nom. nov. Basionym: *Thaxterogaster thiersii* Calhoun 1989, Mycotaxon 34: 65. non *Cortinarius thiersii* Ammirati & A. H. Sm. 1977.

Cortinarius tylostomatoides (Singer) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster tylostomatoides* Singer 1969, Beihefte zur Nova Hedwigia 29: 365.

Cortinarius tympanicus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster tympanicum* E. Horak 1965, Nova Hedwigia X, 224.

Cortinarius violaceovolvatus (E. Horak) Peintner & M.M. Moser comb. nov. Basionym: *Thaxterogaster violaceovolvatum* E. Horak 1973, Beih. Nova Hedwigia 43:95; ut *Thaxterogaster violaceovolvatus*.

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TREMELLA SPICIFERA SP. NOV., A PARASITE OF MASSARINA ARUNDINACEA

VAN RYCKEGEM, G.
Ghent University, Dpt. Biology, Lab. Botany, K.L.Ledeganckstraat 35, B-9000 Gent, Belgium

VAN DE PUT, K.
Herentalsebaan 149, B-2100 Deurne, Belgium

ROBERTS, P.
The Herbarium, Royal Botanic Gardens, Kew, Surrey TW9 3AE, UK

Abstract

Tremella spicifera, a new species parasitic on *Massarina arundinacea*, is described and illustrated from reeds in a tidal marsh of the river Schelde, Belgium.

Keywords

Heterobasidiomycetes, Tremellales, mycoparasitism, fungicolous, marsh

During a survey of fungi on reeds (*Phragmites australis* (Cav.) Steud.) some unusual heterobasidiomycetes were found, including *Tetragoniomyces uliginosus* (P. Karst.) Oberw. & Bandoni (Van de Put et al., 2000) and an unknown *Tremella* species.

One of the collections contained only remarkable, spike-like, clamped, conidiogenous cells bearing conidia formed from a succession of basal clamp-connexions. After incubation in a moist chamber tremellaceous basidia developed and the specimen proved to be identical to earlier collections. These represent a previously unknown *Tremella* species, described as follows:

Tremella spicifera sp. nov., Van Ryckegem, Van de Put & P. Roberts

Etym.: 'spike-bearing', named after the conidiogenous cells which resemble cylindrical grass spikes.

Basidiomata 200- 600 µm lata, hyalina, in *Massarina arudinacea*. **Hyphae** 2-3 µm latae, usque ad 4-6 µm inflatae, fibulatae. **Basidia** 10-15 x 6-9 µm, septo longitudinali usque ad horizontali. **Basidiosporae** 4-5 µm, globosae, hyalinae, apiculatae. **Cellulae conidiogenae** lageniformes, basaliter 4-6 µm latae, collo usque ad 30 µm longo, 1.5 µm lato, spicae similes ob fibulas. **Conidia** 5-8 (12) x 2,5- 4 µm, ellipsoidea vel cylindrica, hyalina, aseptata, guttulata.

Holotypus in Belgia, Provincia Flandria orientalis, Kallo, in palude salsa Scaldis lectus, parasitica *Massarina arundinacea*, 08 V 2000, leg. Van Ryckegem 575 (GENT).

Basidiomes 200-600 µm diam., hyaline, watery-gelatinous, in patches, growing parasitically on perithecia of *Massarina arundinacea*. **Hyphae** 2-3 µm wide, in places inflated up to 4-6 µm wide, hyaline, clamped, frequently anastomosing, with thin-, refractive, or gelatinously thickened walls. **Basidia** 10-15 x 6-9 µm, tremelloid, globose to ovoid, clavate to capitate, with longitudinal or sometimes transverse septa. **Sterigmata** 2-3 (-4), mostly up to 20 x 2 µm, exceptionally up to 65 µm long. **Basidiospores** 4-5 µm, globose, with distinct apiculus, hyaline, aguttulate, sometimes producing secondary spores. **Conidiogenous cells** arising from same hyphae as basidia, sometimes in fascicles, lageniform, 4-6 µm wide at base, neck up to 30 x 1.5 µm, retaining when old the collapsed basal clamp-connexions of the conidia. **Conidia** dikaryotic, 5-8 (-12) x 2.5-4 µm, elliptical to cylindrical, hyaline, with many small guttules, formed laterally and terminally on the conidiophores.

Ecology: all the collections of the host (and parasite) were collected from brackish tidal marshes.

Specimens examined: Belgium, East Flanders, River Schelde, Burcht, tidal marsh, IFBL-coordinates: C4.26.31, 27/03/99, Van Ryckegem 271 (GENT); Belgium, East Flanders, River Schelde, Doel, tidal marsh, IFBL-coordinates: B4.33.43, 27/03/99, Van Ryckegem 291 (GENT), K(M) 82839; Belgium, East Flanders, River Schelde, Kallo, tidal marsh facing Bayer, IFBL-coordinates: B4.54.42, 08/05/00, Van Ryckegem 575 (Holotype, GENT).

Discussion

This small *Tremella* species is characterized by its distinctive conidiogenous cells, the small basidiospores, the often thick-walled hyphae, and the host fungus.

The formation of dikaryotic conidia in the genus *Tremella* often precedes and accompanies basidial development (Chen, 1998). Most species form terminal conidia, catenate conidia, or a few successive conidia. The conidiogenous cells in *Tremella spicifera* resemble those found in *Tremella* *occultifuroidea* C.-J. Chen & Oberw. (Chen et al., 1999) and *T. polyporina* D.A. Reid (illustrated in Koske, 1972). The former is a parasite of *Dacrymyces* species, the latter of polypores. Similar cells have also been reported from *Tremella caloceraticola* Hauerslev, a parasite of *Calocera* (Hauerslev, 1999), and the anamorphic *Tremellina pyrenophila* Bandoni, a parasite of *Ceratocystis* species on palms, whose conidiogenesis was discussed by Bandoni (1986). The lichen parasite, *Tremella stevensiana* Diederich, forms conidiogenous cells producing multiple young conidia which succesively mature. Clamp-connexions are lacking (Diederich & Christiansen, 1994). *Tremella isabellina* Lloyd shows a similar type of conidiogenesis (Bandoni, 1958). Outside the Tremellales, two auricularioid species, *Occultifur internus* (L.S. Olive) Oberw. (Oberwinkler, 1990) and *Platygloea abdita* Bandoni (Bandoni, 1959), form similar conidiogenous cells, as does *Krieglsteinera lasiosphaeriae* Pouzar (illustrated in Læssøe & Lange, 1998).

The very small, globose basidiospores are also exceptional, though not abundantly formed in the material examined. Species producing spores of this size include *Tremella polyporina* (Reid, 1970), *T. colpomaticola* Hauerslev, *T. karstenii* Hauerslev, *T. silvae-dravedae* Hauerslev (Hauerslev, 1999), and several lichenicolous species (Diederich, 1996). Spore germination and a yeast stage have not yet been observed in *Tremella spicifera.*

Many *Tremella* species are mycoparasites of Ascomycetes, but for most of them host-parasite interactions have still to be studied. Haustoria, typical for the genus, were not observed in *Tremella spicifera* but may well occur. No literature records could be found of any other *Tremella* species parasitizing *Massarina arundinacea* (Sowerby: Fr.) Leuchtm. or other members of the Lophiostomataceae (Dothideales).

Acknowledgements

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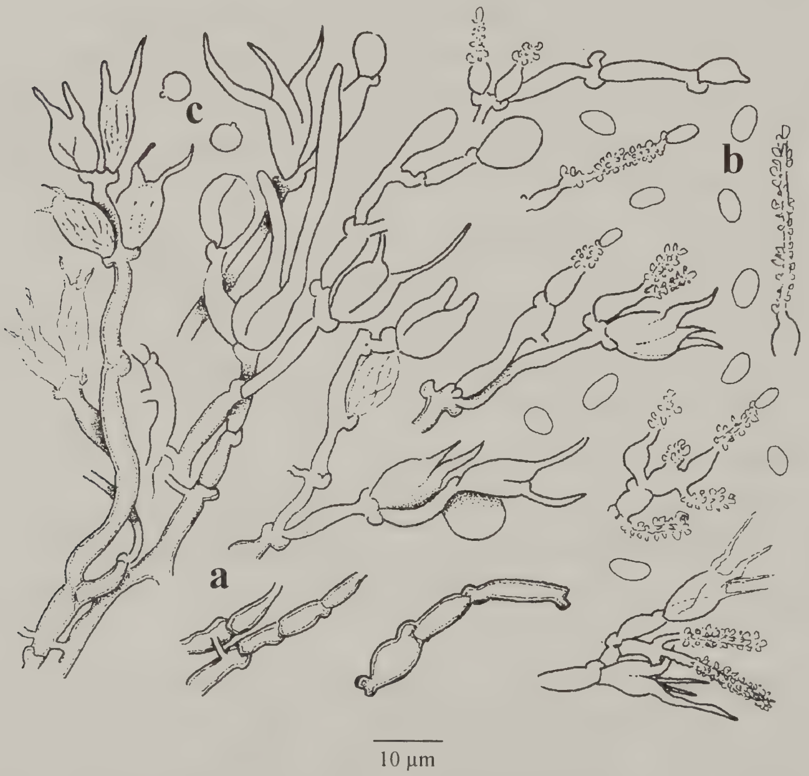

Plate 1. a. Several stages of conidiogenous cells and basidia. Note frequent anastomoses. **b.** Conidia and conidiogenous cells. **c.** Basidiospores.

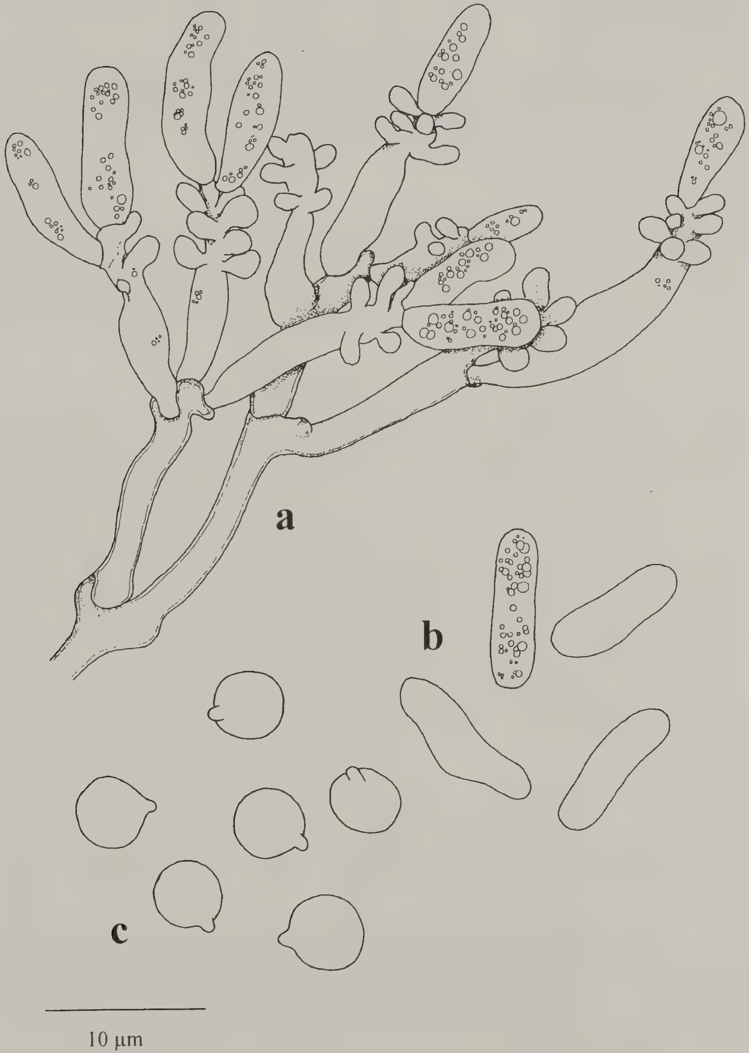

Plate 2. a. Conidiogenous form. **b.** Conidia. **c.** Basidiospores.

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THE MATING SYSTEM IN TWO SPECIES OF CREPIDOTUS

M. Catherine Aime[1] and Jessica Ball

Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061
[1]Present address: Department of Plant Sciences, University of Oxford, Oxford OX1 3RB, U.K.
Email: cathie.aime@plant-sciences.oxford.ac.uk

Abstract

Crepidotus aureifolius and *C. nephrodes* (Agaricales: Crepidotaceae) exhibit a unifactorial (bipolar) mating system. This is the first known report of mating studies conducted in this genus.

Key Words: agarics, basidiospores, bipolar mating system

Introduction

This study is one component of a larger study that will attempt to apply morphological, biological, and phylogenetic species concepts toward a systematic revision of the genus *Crepidotus* (Fr.) Staude. *Crepidotus* is comprised of mostly small, pleurotoid, saprophytic agarics, with an estimated 150 species in the genus (Singer 1986). Section Sphaerula Hesler and Smith contains 42 taxa, including *C. aureifolius* Hesler and Smith and *C. nephrodes* (Berk. & Curt.) Sacc., many of which are distinguished on the basis of single morphological character differences that may or may not be true indicators of non-interbreeding species. In order to apply a biological species concept within this complex the recovery of single spore isolates and determination of mating types is of paramount importance (Petersen 1995). This paper is the first to report on the mating system in a species of *Crepidotus*, based on intracollection pairings of single spore isolates in two collections of *Crepidotus* Section Sphaerula.

Materials and Methods

Specimens: USA: NORTH CAROLINA, Iredell County, West of Bridge 766, 17-Sept. 1997, coll. A. Stanley, MCA 373 (VPI); VIRGINIA, Giles County, Jefferson National Forest, Cherokee Flats, 14-Sept. 1996, M.C. Aime 189 (VPI).

All cultures and mating crosses were grown on malt extract agar (15g Sigma malt extract, 15g Sigma agar, 1 L distilled H_2O) and incubated in the dark at 24-26 C. Methods for dilution plating and isolation of monkaryotic isolates follow Aime (1999). Isolates were stored at 4 C for two-three years prior to use. Isolates were then grown out and examined microscopically for the absence of clamp connections before being used in crosses. Confirmed monokaryons were crossed, in all possible pair-wise combinations, on an individual malt agar plate for each cross, and incubated for approximately four weeks. Hyphae from the contact zone on each cross was then mounted in Congo red and examined under oil immersion; compatible matings were inferred by the presence of clamp connections; the absence of clamp connections was interpreted as an incompatible mating.

The stability of dikaryons was tested by transferring a small portion of the interface from a compatible cross onto a new malt agar plate and incubating for two months or until growth had covered the plate. A portion of the outermost region of the culture was then examined for clamps as above. In addition, all crosses that initially appeared negative at the four-week examination were re-examined after two to eight weeks of additional incubation at 24-26 C.

A total of eight monokaryotic isolates for MCA 373 and six for MCA 189 were recovered which maintained viability throughout the study. These cultures are maintained in the Virginia Tech Culture Collection as VTCC 3600.2, VTCC 3600.4, VTCC 3600.8, VTCC 3600.12, VTCC 3600.14, VTCC 3600.15, VTCC 3600.18, and VTCC 3600.39 (MCA 373) and VTCC 3588.1, VTCC 3588.3, VTCC 3588.5, VTCC 3588.8, VTCC 3588.13, and VTCC 3588.18 (MCA 189).

Results and Discussion

Spore prints from a total of 49 *Crepidotus* collections representing 27 morphological taxa were plated during a three year period in an attempt to obtain monokaryotic single spore isolates (SSIs) (Aime 1999, Aime and Miller Chap. 4). The same studies found that the recovery of SSIs in *Crepidotus* was complicated by a dormant period in the temperate North American species and by a very low rate of germinations per plate. Ultimately, only nine of the collections plated in those studies yielded more than ten SSIs; the largest number of isolates (39) was obtained for collection MCA 373, *C. aureifolius*, which was repeatedly plated to gauge the effect of various abiotic factors on spore dormancy and germination. Furthermore, it was discovered that the viability of monokaryotic isolates was reduced after long term storage at 4 C. As a result, only two collections of *Crepidotus*, MCA 373 and MCA 189, yielded an adequate number of SSIs for inferring mating types.

Figure 1 shows the results from intracollection matings of *Crepidotus aureifolius* (MCA 373). Two mating types were identified indicating the presence of a unifactorial (bipolar) mating system. Assignment of mating types for this collection are shown in Table 1. Figure 2 shows the results from intracollection matings of *Crepidotus nephrodes* (MCA 189), which also indicate a unifactorial system; assignment of mating types are given in Table 2.

Contact zone morphology varied among crosses from almost no observable interaction to a dense hyaline line of mycelium built up at the interaction zone. No correlation could be made between the contact zone morphology and the type of mating interaction. However, there was some tendency for isolates to form certain types of interactions, as has been found in the genus *Melanotus* (Petersen 1992).

	3600.4	3600.8	3600.12	3600.14	3600.15	3600.18	3600.39
3600.2	—	—	—	+	+	—	+
3600.4		—	—	+	+	—	+
3600.8			—	+	+	—	+
3600.12				+	+	—	+
3600.14					—	+	—
3600.15						+	—
3600.18							+

Fig. 1. Intracollection mating of single spore isolates of *Crepidotus aureifolius* (MCA 373). + = clamp connections formed; — = no clamp connections formed.

	3588.3	3588.5	3588.8	3588.13	3588.18
3588.1	+	+	+	—	—
3588.3		—	—	+	—
3588.5			—	+	—
3588.8				+	—
3588.13					+

Fig. 2. Intracollection mating of single spore isolates of *Crepidotus nephrodes* (MCA 189). + = clamp connections formed; — = no clamp connections formed.

Table 1. Assignment of mating types to single spore isolates of *C. aureifolius*, based on intracollection crosses.

Mating type	Isolate number
A1	.2, .4, .8, .12, .18
A2	.14, .15, .39

Table 2. Assignment of mating types to single spore isolates of *C. nephrodes*, based on intracollection crosses.

Mating type	Isolate number
A1	.1, .13,
A2	.3, .5, .8, .18

Specifically, a nodulose interaction zone was only formed in some of the crosses with isolate 3600.18, while a dense build-up of hyaline mycelium forming a line between isolates was found in three of the seven crosses with isolate 3600.4.

The morphology of clamp connections was also diverse and clamp morphology appears to correlate with isolate strain. The majority of dikaryons produced clamps at about 20% of septa. In contrast, one strain (3600.15), when crossed with compatible isolates, produced fewer clamps of reduced size, while compatible crosses formed with isolate 3600.39 produced an abundance of larger clamps.

In some compatible pairings, clamp connections were not observed until the cross had been allowed to incubate for an additional two to eight weeks after a contact zone had been established. However, all dikaryons obtained from the interface of compatible pairings and grown out separately remained stable and continued to exhibit clamp connections at the growing margin after several months incubation.

Since it has been demonstrated that, statistically, a minimum of 11 SSIs from a single collection should be self-crossed to ensure retrieval of all four mating types in a tetrapolar mating system (Vilgalys 1982), it is possible but unlikely that, had more isolates been available for crosses, two additional compatible mating types would have been uncovered, resulting in a bifactorial system for this fungus. However, the same statistics show that at least three mating types are likely to be uncovered when either six or eight SSIs are crossed pair-wise. We therefore conclude that these fungi possess a unifactorial mating system.

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NOMENCLATURAL REVISIONS IN THE SEQUESTRATE RUSSULOID GENERA

James M. Trappe

Department of Forest Science, Oregon State University, Corvallis, Oregon, U. S. A.
97331-5752
trappej@ucs.orst.edu

Teresa Lebel

National Herbarium of Victoria, Royal Botanic Gardens, Birdwood Avenue, South
Yarra, Victoria, Australia 3141
teresa.lebel@rbg.vic.gov.au

Michael A. Castellano

U. S. Department of Agriculture, Forest Service, Pacific Northwest Research Station,
Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, Oregon 97331
mcastellano@fs.fed.us

ABSTRACT

Type studies of the genera of sequestrate russuloid fungi by Lebel and Trappe plus extensive studies of Australasian taxa led to emended generic descriptions of *Cystangium* and *Gymnomyces* and elimination of the genera *Martellia* and *Elasmomyces*. Here we bring names of described species into conformity with these changes by new combinations: *Martellia* spp. are transferred into either *Cystangium* or *Gymnomyces*, *Elasmomyces* spp. into either *Cystangium* or *Macowanites*, and some species are transferred from one to another of the retained genera in keeping with the emended concepts. As a result, 19 names of *Cystangium,* 37 of *Gymnomyces*, and 34 of *Macowanites* are accepted. In our studies of holotypes, 8 species previously described in various genera were found instead to relate to *Lactarius* and are transferred to the genus *Zelleromyces*. One species previously regarded as sequestrate is transferred to the nonsequestrate genus *Russula*. Two species formerly assigned to russuloid genera are transferred to the nonrussuloid genus *Octaviania.*

INTRODUCTION

Singer and Smith (1960) recognized five sequestrate genera related to *Russula*, *Cystangium, Elasmomyces, Gymnomyces, Macowanites* and *Martellia,* and two related to *Lactarius, Arcangeliella* and *Zelleromyces*. They differentiated the genera primarily by presence or absence of 1) a stipe-columella, 2) sphaerocysts in the glebal trama, and

3) latex production, based on species known at that time. Since then many more species have been discovered. Australia especially has proven to be a rich source of russuloid sequestrate fungi, and studies of the Australian taxa have revealed important new data on their morphological relationships (Lebel 1998).

Lebel and Trappe (2000) studied the type species of each of these genera in detail, and Lebel and Castellano (2002) redescribed the holotypes of all published Australasian russuloid species. Calonge and Martin (2000) sequenced DNA of selected species of sequestrate and epigeous Russulales. Taken together, these studies showed that the characters of stipe-columella and tramal sphaerocysts emphasized by Singer and Smith (1960) were often ambiguous, in that many intergradations occurred within and between specimens, species and genera, and confirmed the relationship of these sequestrate genera to the epigeous Russulaceae as postulated by Singer and Smith (1960), thereby rejecting the separation by Pegler and Young (1979) of *Elasmomyces, Gymnomyces, Martellia* and *Zelleromyces* into their artificial family Elasmomycetaceae. Miller *et al.* (2001) sequenced the nuclear large subunit rDNA of an array of Russulaceae, including both agaricoid and sequestrate species. Their data further confirmed the phylogenetic relationships between the two groups and indicated that the sequestrate taxa arose along several different lineage's within the Russulaceae.

Lebel and Trappe (2000) emended the generic concepts of the sequestrate russuloid fungi to clarify distinctions between genera as follows:

Cystangium with or without stipe-columella; peridiopellis with either a single, exposed epithelial layer of inflated, often isodiametric cells or two layers with the epithelium underlying a suprapellis of hyphae and/or cystidia; gleba sublamellate or loculate.
Gymnomyces without a stipe but sometimes with a reduced columella; peridiopellis a trichodermium, a turf or of undifferentiated hyphae; gleba loculate.
Macowanites with stipe-columella; peridiopellis a trichodermium, a turf or of undifferentiated hyphae; gleba sublamellate or loculate.

Martellia and *Elasmomyces* were eliminated; *Martellia* species would be reassigned to either *Cystangium* or *Gymnomyces* and *Elasmomyces* species to either *Cystangium* or *Macowanites,* in both cases depending on anatomy of the peridiopellis. This revision removed much of the ambiguity inherent in the generic concepts of Singer and Smith (1960), but Lebel and Trappe (2000) regarded it as an interim solution pending development of a comprehensive molecular phylogeny of the Russulaceae. Miller *et al.* have taken a further step towards that goal. However, much additional research is needed to produce such a phylogeny, which must be based on concordance of multiple gene genealogies (Taylor *et al.* 2000). Until that happens, researchers on taxonomy, ecology and physiology of these important fungi need a useable nomenclatural system to organize and communicate their research results. In the present paper we recombine previously described russuloid sequestrate species for which we have adequate data either from our examination of holotypes or from type descriptions to bring them into conformity with the generic concepts as emended by Lebel and Trappe (2000). As a result, 19 names of *Cystangium,* 37 of *Gymnomyces*, and 34 of *Macowanites* are accepted. Taxonomic synonyms are listed when we have confirmed them, but it must be remembered that the recombinations are mostly nomenclatural changes and should not necessarily be regarded as final taxonomic conclusions.

Some species originally placed in one or another of these genera proved to belong to the *Lactarius*-related genera *Arcangeliella* or *Zelleromyces*. In our studies of holotypes, 8 species previously described in various genera were found instead to relate to *Lactarius* and are transferred to the genus *Zelleromyces*. Names of sequestrate lactarioid species are not otherwise listed, because we have not completed our studies of them. *Macowanites americanus* Singer & A. H. Sm. was judged to be a nonsequestrate *Russula* spp. and is renamed *R. subloculata* to avoid erecting a homonym to *Russula americana* (Singer) Singer. These new names are included here under the heading "Excluded species." Species for which type collections have not been examined or type descriptions are inadequate are listed under the heading "Uncertain species." All references are cited in full in the Literature Cited section to provide a complete bibliography and facilitate literature search and acquisition by any who have an interest in these fungi.

All new names and combinations are indicated in boldface. An index to species names, some of which have appeared under as many as five different genera in the past, is provided after the Literature Cited.

ACCEPTED NAMES, NEW COMBINATIONS, AND SYNONYMS OF *RUSSULA*-RELATED SEQUESTRATE SPECIES

Cystangium balpineum Grgur., Larger Fungi of South Australia, p. 53. 1997.

***Cystangium capitis-orae* (Dring) T. Lebel comb. nov.**

BASIONYM: *Elasmomyces capitis-orae* Dring in Dring & Pegler, Kew Bull. 32: 564-566. 1978.

Cystangium depauperatum Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 69-70. 1960.

***Cystangium echinosporum* (Zeller & C. W. Dodge) Trappe, T. Lebel & Castellano, comb. nov.**

Basionym: *Macowanites echinosporus* Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 6: 57-58. 1919.

≡ *Elasmomyces echinosporus* (Zeller & C. W. Dodge) Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 22: 370. 1935.

***Cystangium idahoensis* (Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Martellia idahoensis* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 43-44. 1960.

***Cystangium lymanensis* (Cázares & Trappe) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Macowanites lymanensis* Cázares & Trappe, Mycotaxon 42: 335. 1991.

***Cystangium maculatum* (Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Martellia maculata* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 28-29. 1960.

***Cystangium medlockii* (Trappe & Castellano) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Martellia medlockii* Trappe & Castellano, Mycologia 78: 918-919. 1986.

Cystangium megasporum (Rodway) T. Lebel & Castellano, Mycologia 94 (in press) 2002.
≡ *Gymnomyces megasporus* Rodway, Paps. Proc. Roy. Soc. Tasmania 1925: 168. 1926.
≡ *Octaviania megaspora* (Rodway) G. Cunn., N. Zeal. J. Sci. Tech. 22: 300B. 1941.
Cystangium nothofagi **(E. Horak) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Elasmomyces nothofagi* E. Horak, Sydowia 17: 211-212. 1964a.
Cystangium oregonense **(Zeller) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Hydnangium oregonense* Zeller, Mycologia 33: 200. 1941.
≡ *Martellia oregonensis* (Zeller) Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 27. 1960.
Cystangium phymatidosporum G. W. Beaton, Pegler & T. W. K. Young, Kew Bull. 39: 672-674. 1984.
Cystangium pineti Singer, Mycol. Helvetica 1: 417-419, 1985.
Cystangium rodwayi (Massee) A. H. Sm., Mycologia 54: 633. 1962.
≡ *Secotium rodwayi* Massee, Kew Bull. Misc. Inf. 1901: 158. 1901.
≡ *Elasmomyces rodwayi* (Massee) Zeller, Mycologia 40: 642. 1948.
Cystangium seminudum (Massee & Rodway) T. Lebel & Castellano, Mycologia 94 (in press) 2002.
≡ *Gymnomyces seminudus* Massee & Rodway in Massee, Bull. Misc. Inf. Kew 1898: 125. 1898.
≡ *Arcangeliella seminuda* (Massee & Rodway) Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 23: 617. 1936.
≡ *Octaviania seminuda* (Massee & Rodway) G. Cunn., Trans. Roy. Soc. New Zeal. 67: 408. 1938.
= *Gymnomyces solidus* Rodway, Paps. Proc. Roy. Soc. Tasmania 1920: 157. 1921.
Cystangium sessile (Massee & Rodway) Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 67. 1960.
≡ *Secotium sessile* Massee & Rodway in Rodway, Paps. Proc. Roy. Soc. Tasmania 1911: 31. 1912.
≡ *Elasmomyces sessilis* (Massee & Rodway) Rodway, Paps. Proc. Roy. Soc. Tasmania 1924: 8. 1925.
Cystangium thaxteri **(Singer) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Martellia thaxteri* Singer, Nova Hedwigia Beih. 29: 357. 1969.
Cystangium variabilisporum **(Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Martellia variabilispora* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 27-28. 1960.
Cystangium vesiculosum **(Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Martellia vesiculosa* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 29. 1960.
Gymnomyces albus **(Harkn.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Hydnangium album* Harkn., Proc. Cal. Acad. Sci. III, 1: 251. 1899.
≡ *Martellia alba* (Harkn.) Singer & Sm., Mem. Torrey Bot. Club 21: 41. 1960.
Gymnomyces ammophilus J. M. Vidal & Calonge in Calonge & J. M. Vidal, Bol. Soc. Micol. Madrid 24: 66. 1999.

Gymnomyces brunnescens **(Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Martellia brunnescens* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 37-38. 1960.

Gymnomyces californicus **(Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Martellia californica* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 33-34. 1960.

Gymnomyces cinnamomeus Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 51. 1960.

Gymnomyces citrinus **(Harkn.) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Octaviania citrina* Harkn., Proc. Cal. Acad. Sci. III, 1: 252. 1899.

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BASIONYM: *Arcangeliella cremea* Zeller & C. W. Dodge, Ann. Mo. Bot. Gard. 22: 367. 1935.

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BASIONYM: *Hydnangium ellipsosporum* Zeller, Mycologia 31: 13. 1939.

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BASIONYM: *Martellia fallax* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 34-35. 1960.

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BASIONYM: *Martellia foetens* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 36-37. 1960.

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BASIONYM: *Martellia fragrans* A. H. Sm., Mycologia 55: 437. 1963.

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BASIONYM: *Martellia fulvispora* A. H. Sm., Mycologia 55: 438. 1963.

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BASIONYM: *Hydnangium gilkeyae* Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 22: 371. 1935.

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BASIONYM: *Octaviania monticola* Harkn., Proc. Cal. Acad. Sci. III, 1: 254. 1899.
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≡ *Martellia monticola* (Harkn.) Singer & Sm., Mem. Torrey Bot. Club 21: 40. 1960.

***Gymnomyces nanjingensis* (B. Liu & K. Tao) Trappe, T. Lebel & Castellano, comb. nov.**
Basionym: *Martellia nanjingensis* B. Liu & K. Tao in K. Tao, M. C. Chang & B. Liu, Acta Mycol. Sinica 12: 103. 1993.

***Gymnomyces occidentalis* (Harkn.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Octaviania occidentalis* Harkn., Proc. Cal. Acad. Sci. III, 1: 253. 1899.

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BASIONYM: *Hydnangium pila* Pat., Bull. Tri. Soc. Mycol. France 26: 201. 1910.
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BASIONYM: *Octavianina rogersii* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 12-13. 1960.

***Gymnomyces rolfalexii* Trappe, T. Lebel & Castellano, nom. nov.**
BASIONYM: *Martellia parksii* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 32-33, 1960, non *Gymnomyces parksii* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 55. 1960.
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BASIONYM: *Hydnangium setigerum* Zeller, Mycologia 31: 14-15. 1939.
≡ *Martellia setigera* (Zeller) Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 39 1960.
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BASIONYM: *Martellia subalpina* A. H. Sm., Mycologia 55: 439. 1963.
***Gymnomyces subfulvus* (Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Martellia subfulva* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 35-36. 1960.
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BASIONYM: *Martellia subochracea* A. H. Sm., Mycologia 55: 440. 1963.
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≡ *Secotium krjukowensis* Buchholtz, Hedwigia 40: 314. 1901.
≡ *Elasmomyces krjukowensis* (Buchholtz) Sacc. & D. Sacc., Syll. Fung. 17: 218. 1905.
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≡ *Elasmomyces mollis* (Singer & A. H. Sm.) Pegler & T. W. K. Young, Trans. Brit. Mycol. Soc. 72: 368. 1979.
Macowanites nauseosus A. H. Sm., Mycologia 55: 428-429. 1963.
***Macowanites odoratus* (Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Elasmomyces odoratus* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 57. 1960.
Macowanites olidus A. H. Sm., Mycologia 55: 429-430. 1963.
***Macowanites pilosus* (Zeller & C. W. Dodge) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Arcangeliella pilosa* Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 22; 368. 1935.
≡ *Elasmomyces pilosus* (Zeller & C. W. Dodge) Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 66. 1960.
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≡ *Elasmomyces roseipes* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 64-65. 1960.
***Macowanites russuloides* (Setch.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Elasmomyces russuloides* Setch., J. Mycol. 13: 240. 1907.
Macowanites setchellianus Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 92-93. 1960.
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BASIONYM: *Elasmomyces stipitatus* H. A. Peters, Mycologia 54: 112. 1962.
Macowanites subolivaceus A. H. Sm., Mycologia 55: 432-433. 1963.

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BASIONYM: *Elasmomyces zellerianus* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 61-62. 1960.

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Arcangeliella crichtonii (G. W. Beaton, Pegler & T. W. K. Young) T. Lebel & Castellano, Mycologia 94 (in press) 2002.
  ≡ *Cystangium crichtonii* G. W. Beaton, Pegler & T. W. K. Young, Trans. Brit. Mycol. Soc. 86: 181-182. 1986.
Arcangeliella hepaticus (G. W. Beaton, Pegler & T. W. K. Young) T. Lebel & Castellano, Mycologia 94 (in press) 2002.
  ≡ *Elasmomyces hepaticus* G. W. Beaton, Pegler & T. W. K. Young, Kew Bull. 39: 676-677. 1984b.
Arcangeliella texta (J. W. Cribb) Pegler & T. W. K. Young, Trans. Brit. Mycol. Soc. 72: 365. 1979.
  ≡ *Secotium sessile* var. *textum* J. W. Cribb, Paps. Dept. Bot. Univ. Queensland 3: 108. 1956.
  ≡ *Elasmomyces texta* (J. W. Cribb) A. H. Sm., Mycologia 54: 638. 1962.
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= *Octaviania socialis* Harkn., Proc. Cal. Acad. Sci. Ser. 3, 1: 252. 1899.
  ≡ *Arcangeliella socialis* (Harkn.) Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 22: 369. 1935.
  ≡ *Gymnomyces socialis* (Harkn.) Singer & Sm., Mem. Torrey Bot. Club 21: 52. 1960.
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  ≡ *Elasmomyces borneensis* (Petri) Zeller & C. W. Dodge. Ann. Missouri Bot. Gard. 22: 370. 1935.
  ≡ *Octavianina borneensis* (Petri) Pegler & T. W. K. Young, Trans. Brit. Mycol. Soc. 72: 380. 1979.
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BASIONYM: *Secotium lamingtonense* J. W. Cribb, Pap. Dept. Bot. Univ. Queensland 3: 107. 1956.
  ≡ *Elasmomyces lamingtonensis* (J. W. Cribb) A. H. Sm., Mycologia 54: 637. 1962.

≡ *Octavianina lamingtonensis* (J. W. Cribb) Pegler & T. W. K. Young, Trans. Brit. Mycol. Soc. 72: 380. 1979.

Octaviania malaiensis **(Corner & Hawker) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Elasmomyces malaiensis* Corner & Hawker, Trans. Brit. Mycol. Soc. 36: 129. 1953.

≡ *Octavianina malaiensis* (Corner & Hawker) Pegler & T. W. K. Young, Trans. Brit. Mycol. Soc. 72: 382. 1979.

Russula subloculata **Trappe, T. Lebel & Castellano, nom. nov.**

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Zelleromyces albellus **(Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**

BASIONYM: *Martellia albellus* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 38-39. 1960.

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BASIONYM: *Gymnomyces alveolatus* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 51-52. 1960.

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BASIONYM: *Gymnomyces lactifer* B. C. Zhang & Y. N. Yu, Mycol. Res. 94: 457-458. 1990.

Zelleromyces papyraceus **(Singer & A. H. Sm.) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Octavianina papyracea* Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 13-14. 1960.

Zelleromyces pterosporus **(E. Horak) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Martellia pterospora* E. Horak, Sydowia 17: 310-311. 1964b.

Zelleromyces ramisporus **(B. C. Zhang & Y. N. Yu) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Martellia ramispora* B. C. Zhang & Y. N. Yu, Mycol. Res. 94: 459. 1990.

Zelleromyces scissilis **(Zeller & C. W. Dodge) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Arcangeliella scissilis* Zeller & C. W. Dodge, Ann. Mo. Bot. Gard. 22: 369. 1935.
≡ *Martellia scissilis* (Zeller & C. W. Dodge) Singer & A. H. Sm., Mem. Torrey Bot. Club 21: 45. 1960.
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Zelleromyces soehneri **(Zeller & C. W. Dodge) Trappe, T. Lebel & Castellano, comb. nov.**
BASIONYM: *Hydnangium soehneri* Zeller & C. W. Dodge, Ann. Missouri Bot. Gard. 22: 372. 1935.
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≡ *Hydnangium monosporum* Boud. & Pat., J. Bot. (Morot) 2: 445. 1888.
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Octaviania moravica Velen., Novit. Mycol. 2: 95, 1950.
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Zelleromyces sinensis B. Liu, K. Tao & M. C. Chang in K. Tao, M. C. Chang & B. Liu, Acta Mycol. Sinica 12: 104. 1993.

DISCUSSION

In addition to the recombinations generated by the emendation of genera by Lebel and Trappe (2000), the number of taxa transferred to *Zelleromyces* resulting from our examination of holotypes and holotype descriptions surprised us. This stems at least in part from the requirement of Singer and Smith (1960) that fresh specimens produce a visible latex to qualify as *Zelleromyces* spp. Thus, if the description of a new taxon by an earlier author or notes on a collection did not indicate latex production, Singer and Smith would not consider that material as a *Zelleromyces.* We have collected *Zelleromyces* spp. hundreds of times in both North America and Australia. Many species, *e.g. Zelleromyces scissilis* (formerly *Z. gilkeyae*), are readily recognizable macroscopically regardless of latex production. In dry weather or if specimens are senescent or not cut open immediately upon collection, no latex may be exuded when specimens are cut later, just as also can happen with *Lactarius* spp. In some species, the latex is whey-like or watery and hence inconspicuous. In these cases, microscopic examination can confirm not only the species identity but also the presence and usual abundance of laticiferous hyphae.

Zelleromyces gilkeyae offers a good example of the confusion resulting from the insistence of visible latex production to qualify a taxon as a *Zelleromyces* sp. The collector of the holotype, Prof. Helen Gilkey, indicated production of a white latex in her notes on the collection. Hence, Singer and Smith (1960) had no problem assigning the species to *Zelleromyces.* A collection by H. E. Parks described by Zeller & Dodge (1935) as *Arcangeliella scissilis* contained no such notation. Even though the two dried collections were identical macroscopically and microscopically, including presence of lactiferous hyphae, Singer and Smith (1960) recombined the Parks collection as *Martellia scissilis.* As it is definitely a latex producer and the epithet *scissilis* has priority, we have recombined it as *Zelleromyces scissilis* with *Z. gilkeyae* as a synonym

Another example is *Zelleromyces alveolatus,* described as a *Gymnomyces* sp. by Singer and Smith (1960). S. M. Zeller's notes on the collection said nothing about latex, and in this species the laticiferous hyphae are relatively sparse. We have collected it several times (Trappe nos. 3779, 5128, 6502, 21137) and regarded it as an undescribed *Zelleromyces,* because it usually (but not always) produced a whey-like latex. In the present study, however, we were alerted to re-examine our collections in light of the description of *Gymnomyces alveolatus* and confirmed them to be the same species, a latex producer.

In all cases where we have recombined species into *Zelleromyces* from other genera, the collections have abundant laticiferous hyphae and, in some cases, were even originally described as producing latex. These new insights result in a near doubling of the recognized species of *Zelleromyces.* We have many more undescribed species from Australia, so the genus *Lactarius* appears to be on a par with *Russula* in the diversity of its sequestrate relatives.

Singer and Smith (1960) transferred *Octaviania socialis* Harkn. to the genus *Gymnomyces.* We have examined the holotype of this species, Harkness #232, and its basidiospores are totally inamyloid. In all other respects it fits the description of *Hydnangium carneum,* including association with *Eucalyptus globulus.* We were puzzled by Singer and Smith's disposition of this species until we realized they did not examine the holotype. Their concept was based on a later collection, Parks #979, which has strongly amyloid spores and is possibly a *Zelleromyces* sp., judging from the presence of laticiferous hyphae. We have placed *Octaviania (Gymnomyces) socialis* in synonymy with *Hydnangium carneum.*

Differing opinions on whether or not *Octaviania asterosperma* Vittad. well represented the genus *Octaviania* or not led to erection of the genus *Octavianina* to accommodate the species; the nomenclatural history is reviewed by Pegler, *et al.* (1993). However, designation of *Octaviania asterosperma* as a monotypic genus by Tulasne & Tulasne (1843) and affirmation of *O. asterosperma* as the type species of *Octaviania* by Clements and Shear (1931) requires retention of the name *Octaviania* and rejection of *Octavianina.* Accordingly, under "Excluded Species" we transferred two species related to *O. asterosperma* from *Octavianina* to *Octaviania*

The basis for transferring *Macowanites americanus* to *Russula* (as *Russula subloculata*) is that it is not sequestrate: it has ballistospores, the pileus expands fully, the stipe is as fully developed as many *Russula* spp., and it is typically epigeous. Singer and Smith (1960) placed it in *Macowanites* primarily because the lamellae are more intervenose than usual for *Russula,* sometimes enough to form open locules, but these are not sequestrate and discharged spores can escape. Similar variants on the usual agaric form occur occasionally in other genera, *e.g. Chroogomphus loculatus* O. K. Miller & Trappe (1970).

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INDEX TO SPECIES

Each species name is followed by the accepted genus name, then by other generic names of past usage in parentheses. EX after the accepted genus name indicates the species is in the excluded species list. UN after the available genus name indicates the status of the species is uncertain and is listed under "Uncertain Species." In the case of species epithets that are taxonomic synonyms of accepted epithets, the accepted epithet under which the synonym is listed is indicated by =.

acris, Macowanites
agaricinus, Macowanites (Macowania)
albellus, Zelleromyces EX *(Martellia)*
albidigleba, Macowanites
albus, Gymnomyces (Hydnangium, Martellia)
alveolata, Octaviania EX *(Arcangeliella, Hydnangium, Martellia, Octavianina) = Zelleromyces australiensis*
alveolatus, Zelleromyces EX *(Gymnomyces)*
americanus, Macowanites EX = *Russula subloculata*
ammophilus, Gymnomyces
aurantiaca, Martellia UN *(Hydnangium)*
australiensis, Zelleromyces EX *(Arcangeliella, Hydnangium, Martellia, Octaviania)*

balpineum, Cystangium
berkeleyi, Martellia EX = *Zelleromyces australiensis*
borneensis, Octaviania EX *(Elasmomyces, Octavianina)*
brisbanensis, Hydnangium EX *(Octaviania) = Zelleromyces australiensis*
brunnescens, Gymnomyces (Martellia)
californicus, Gymnomyces (Martellia)
camphorata, Arcangeliella EX, *(Elasmomyces)*
carmineus, Macowanites
carneum, Hydnangium EX
carneum var. xanthosporum (Hydnangium) = Gymnomyces xanthosporum
capitis-orae, Cystangium (Elasmomyces)
chlorinosmus, Macowanites
cinnamomeus, Gymnomyces
citrinus, Gymnomyces (Hydnangium, Octaviania)
citrinus, Macowanites
compactus, Gymnomyces
cremeus, Gymnomyces (Arcangeliella, Martellia)
crichtonii, Arcangeliella EX, *(Cystangium)*
depauperatum, Cystangium
dominguezii, Gymnomyces
durangensis, Macowanites
echinosporum, Cystangium (Elasmomyces, Macowanites)
eildonensis, Gymnomyces
ellipsosporus, Gymnomyces (Hydnangium, Martellia)
fallax, Gymnomyces (Martellia)
ferruginascens, Gymnomyces
foetens, Gymnomyces (Martellia)
fragrans, Gymnomyces (Martellia)
fulvescens, Macowanites
fulvisporus, Gymnomyces (Martellia)
fuscoviolaceus, Macowanites
galileensis, Macowanites
gilkeyae, Gymnomyces (Hydnangium, Martellia)
gilkeyae, Zelleromyces EX = *Zelleromyces scissilis*
glabrum, Hydnangium EX *(Octaviania) = Zelleromyces australiensis*
hepatica, Arcangeliella EX *(Elasmomyces)*
hinsbyi, Hydnangium (Octaviania) = Gymnomyces pallidus
idahoensis, Cystangium (Martellia)
ilicis, Gymnomyces
iodiolens, Macowanites
krjukowensis, Macowanites (Arcangeliella, Bucholtzia, Elasmomyces, Hydnangium,, Secotium)
krjukowensis var. *michailowskiana, Arcangeliella* = *Macowanites krjukowensis*
krjukowensis var. *moravicum, Hydnangium* UN = *Octaviania moravica*
lactifer, Zelleromyces EX *(Gymnomyces)*
lamingtonensis, Octaviania EX *(Elasmomyces, Octavianina, Secotium)*
lilacinus, Macowanites
luteiroseus, Macowanites
luteolus, Gymnomyces (Hydnangium)

luteolus, Macowanites
lymanensis, Cystangium (Macowanites)
maculatum, Cystangium (Martellia)
magnus, Macowanites (Arcangeliella)
malaiensis, Octaviania EX *(Elasmomyces, Octavianina)*
mattirolanus, Macowanites (Elasmomyces, Secotium)
mediterranea, Martellia = Gymnomyces pila
medlockii, Cystangium (Martellia)
megasporum, Cystangium (Gymnomyces, Octaviania)
mediterranea, Martellia = Gymnomyces pila
messapicoides, Macowanites
mexicanus, Macowanites
mediterranea, Martellia = Gymnomyces pila
michailowskianus, Macowanites (Elasmomyces, Secotium, Arcangeliella krjukowensis var. *michailowskiana)*
mistiformis, Gymnomyces (Hydnangium, Martellia, Octaviania)
mollis, Macowanites (Elasmomyces)
monospora, Martellia UN *(Hydnangium, Octaviania)*
monosporus, Gymnomyces
monticola, Gymnomyces (Hydnangium, Martellia, Octaviania)
moravica, Octaviania UN
nanjingensis,Gymnomyces (Martellia)
nauseosus, Macowanites
nothofagi, Cystangium (Elasmomyces)
occidentalis, Gymnomyces (Octaviania)
occidentalis, Martellia UN
odoratus, Macowanites (Elasmomyces)
olidus, Macowanites
oregonense, Cystangium (Hydnangium, Martellia)
pallidus, Gymnomyces (Octaviania)
papyraceus, Zelleromyces EX *(Octavianina)*
parksii, Gymnomyces
parksii, Martellia = Gymnomyces rolfalexii
phymatidosporum, Cystangium
pila, Gymnomyces (Hydnangium, Martellia)
pilosus, Macowanites (Arcangeliella, Elasmomyces)
pineti, Cystangium
pinicola, Macowanites
pseudoemeticus, Macowanites UN
pterosporus, Zelleromyces EX *(Martellia)*
ramisporus, Zelleromyces (Martellia)
redolens, Gymnomyces (Martellia, Octaviania, Stephanospora)
rodwayi, Cystangium (Elasmomyces, Secotium)
rogersii, Gymnomyces (Octavianina)
rolfalexii, Gymnomyces
roseipes, Macowanites (Elasmomyces)
roseomaculatus, Gymnomyces
russuloides, Macowanites (Elasmomyces)
scissilis, Zelleromyces EX *(Arcangeliella, Martellia)*

seminudum, Cystangium (Arcangeliella, Gymnomyces, Octaviania)
sessile, Cystangium (Elasmomyces, Secotium)
sessile var. *textum; Secotium =Arcangeliella texta*
setchellianus, Macowanites
setigerus, Gymnomyces (Hydnangium, Martellia)
sinensis, Zelleromyces UN
socialis, Gymnomyces EX *(Arcangeliella, Octaviania) = Hydnangium carneum*
soehneri, Zelleromyces EX *(Hydnangium, Martellia, Octaviania)*
solidus, Gymnomyces, = Cystangium seminudum
sessile, Cystangium (Elasmomyces, Secotium)
stipitatus, Macowanites (Elasmomyces)
subalpinus, Gymnomyces (Martellia)
subfulvus, Gymnomyces (Martellia)
subloculata, Russula EX
subochraceus, Gymnomyces (Martellia)
subolivaceus, Macowanites
subrosaceus, Macowanites
texta, Arcangeliella EX *(Elasmomyces, Secotium sessile* var. *textum)*
thaxteri, Cystangium (Martellia)
tomentosus, Macowanites (Hydnangium, Martellia)
variabilisporum, Cystangium (Martellia)
vesciculosa, Gymnomyces UN
vesiculosum, Cystangium (Martellia)
vinicolor, Macowanites
wirrabarensis, Gymnomyces
xanthosporus, Gymnomyces (Hydnangium carneum var. xanthosporum)
zellerianus, Macowanites (Elasmomyces)

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CORTICIOID AND POLYPOROID FUNGI (BASIDIOMYCOTA) THAT DECAY AUSTROCEDRUS CHILENSIS IN PATAGONIA, ARGENTINA

MARIO RAJCHENBERG
Centro de Investigación y Extensión Forestal Andino Patagónico (CIEFAP),
C.C. 14, 9200 Esquel, Chubut, Argentina. E-mail: marior@ciefap.cyt.edu.ar

ABSTRACT

Corticioid and polyporoid fungi that decay *Austrocedrus chilensis* in southern Argentina were studied. Only 52 Corticiaceae s.l. and 13 Polypores were found, pointing out this conifer as a rather poor substrate for these groups of fungi. *Fibricium gloeocystidiatum* and *Tubulicrinis ellipsoideus* are described as new taxa; the former is characterised by the presence of gloeopleurous hyphae and sulfonegative gloeocystidia and the latter by the combination of large ellipsoid spores and lyocystidia with slightly swollen apices. None of the taxa could be assigned to the species responsible of the white heart-rots present in standing trees. The following species are new records for Argentina: *Aleurocystidiellum subcruentatum*, *Hyphoderma echinocystis*, *Leptosporomyces galzinii*, *Trechispora praefocata*, *Tubulicrinis chaetophorus* and an *Antrodia* sp. Most of the species are recorded for the first time on *A. chilensis*.

Key words: Aphyllophorales, Corticiaceae, Polyporaceae, Wood-rots

INTRODUCTION

Austrocedrus chilensis (D.Don) Flor. & Bout. (v.n. "ciprés de la cordillera") is an endemic Cupressaceae of the subantarctic forests of Argentina and Chile. In Argentina it is distributed in the Patagonian Andes and its piedmont. It forms pure stands in a precipitation gradient between 500 mm in the east to 1700 mm in the west, where it forms mixed stands with *Nothofagus dombeyi* (Mirb.) Oerst. The area occupied by *Austrocedrus* forests has been estimated at approximately 200,000 ha in Argentina (Dezzotti & Sancholuz 1991). Cypress forests are an important economic resource for Patagonia, being second in importance in forestry, after "Lenga" [*Nothofagus pumilio* (Poepp. & Endl.) Krass.], also forming the environment where most human settlements have been established. The ecology of *Austrocedrus chilensis* has been summarized by Veblen et al. (1995) and Donoso Z. (1993). A decline of cypress has been detected about 50 years ago and has been the centre of several studies that tried to understand it (Havrylenko et al. 1989, Filip & Rosso 1999, Calí 1996, Rajchenberg & Cwielong 1993, Baccalá et al. 1998, among others), because the disease has an important impact on the conservation of the species.

Fungi have been paid attention in relation to the decline of *A. chilensis* (Rajchenberg et al. 1998) and in relation to the development of heartrots and saprots in standing trees (Barroetaveña & Rajchenberg 1996). Regular sampling of corticioid and polyporoid fungi (Aphyllophorales, Basidiomycota) since 1991 has yielded a list of species that is here presented as a preliminary account of wood decaying Aphyllophorales of cypress. *Ceraceomyces* Jülich and *Hyphodontia* J. Erikss. species were recorded by Greslebin & Rajchenberg (1999, 2000). Information on polypores has been published previously by Wright & Deschamps (1972), Rajchenberg (1983, 1993) and Rajchenberg & Greslebin (1998).

The aim of this paper has been both floristic and pathological, and the search of the agent responsible of the above mentioned heartrots has been of concern.

MATERIALS AND METHODS

Study of materials: Freehand sections of both fresh and dried herbarium material were mounted in 3% KOH plus 1% aqueous phloxine and in Melzer's reagent (reaction amyloid, dextrinoid or IKI-). Material of some species was also examined in a 1% aqueous solution of Brilliant Cresyl Blue to test for a metachromatic reaction (red coloration) in hyphae. Line drawings of microscopic features were made using a drawing tube on a microscope. Specimens are kept at the Pathology Herbarium of CIEFAP unless differently indicated in the text.

Sampling locations: Specimens were gathered in most of the distributional range of *A. chilensis* in Argentina, but efforts were concentrated in Chubut Province because of the relative proximity of most locations to the author's address. They include, nevertheless, all the ecological forest types of cypress (Dezzotti & Sancholuz 1991). To save space, the following list gives codes to the locations and collecting dates of most specimens gathered by the author. In the text, the codes are followed by collecting numbers that correspond to the author, except when differently indicated. "MR s.n." indicates collections of the author that were not given a number. An asterisk (*) before a species' name indicates a new addition to the Corticioid flora of Argentina. Most other species were recently recorded by Greslebin (2001) for Tierra del Fuego, Argentina, on a different substrate.

A) Argentina, Chubut, Futaleufú, Trevelin, Estación Agroforestal INTA Esquel
  A1) 3.May.1991 - A2) 5.Apr.1992 - A3) 13.Oct.1994 - A4) 15.Nov.1996 - A5) 20.Nov.1996 - A6) 15-20.Dec.1996 - A7) 11.Feb.1997 - A8) 6.Mar.1997
B) Argentina, Chubut, Futaleufú, Los Cipreses, 'La 106'
  B1) 23.May.1991 - B2) 29.May.1991 - B3) 18.Jun.1991 - B4) 25.Jun.1991 - B5) 03.Jul.1991 - B6) 25.Feb.1992 - B7) 30.Apr.1992 - B8) 15.Apr.1993 - B9) 15.Feb.1994 - B10) 24.Mar.1995 - B11) 22.Sep.1995 - B12) 9.Oct.1995 - B13) 11.Dec.1995
C) Argentina, Chubut, Futaleufú, Nant y Fall falls, 23.May.1996
D) Argentina, Chubut, Futaleufú, Los Cipreses, Arroyo Los Rifleros
  D1) 18.Aug.1995 - D2) 11.Aug.2000
E) Argentina, Chubut, Futaleufú, Los Cipreses, property 'Pehuen'
  E1) 15.Mar.1997 - E2) 10.Apr.1997 - E3) 6.Jun.1997
F) Argentina, Chubut, Futaleufú, Los Cipreses, property of M. Criados
  F1) 6.Jun.1994 - F2) 16.Jun.1994
G) Argentina, Chubut, Futaleufú, Corcovado, 10 km towards Carrenleufú, 31.Jun.1993
H) Argentina, Chubut, Parque Nacional Lago Puelo, W arm of Lake Puelo, E slope of Valle de las Lágrimas
  H1) 18.Mar.1993 - H2) 10.May.1996 - H3) 4.May.1998
I) Argentina, Chubut, Parque Nacional Lago Puelo, W arm of Lago Puelo, Los Calabozos, 4.May.1998

J) Argentina, Chubut, Parque Nacional Lago Puelo, W arm of Lake Puelo, international limit with Chile, mixed forest of *A. chilensis* + *N. dombeyi* + *Guevinia avellana*, 10.May.1996

K) Argentina, Chubut, Parque Nacional Lago Puelo, Cerro Bajo, mixed forest of *A. chilensis* + *Nothofagus dombeyi* + *Guevinia avellano*, 13.Nov.1995

L) Argentina, Chubut, Parque Nacional Los Alerces, Lago Futalaufquen, track to Cinco Saltos, 19.Nov.1993

M) Argentina, Chubut, Parque Nacional Los Alerces, Lago Futalaufquen, Punta Brava, 21.Mar.1995

N) Argentina, Chubut, Parque Nacional Los Alerces, Lago Rivadavia, Arroyo Coligual, mixed forest of *A. chilensis* + *N. dombeyi*, 17.Jun.1997

O) Argentina, Chubut, Parque Nacional Los Alerces, Lago Futalaufquen track to Lago Krugger, 6.May.1998

P) Argentina, Chubut, Parque Nacional Los Alerces, track along Río Arrayanes and Río Menéndez, 30.Mar.2000

Q) Argentina, Chubut, Parque Nacional Los Alerces, Río Grande, settlement of Mr. Burgos, 12.Oct.2000

R) Argentina, Chubut, Cushamen, Las Golondrinas, stand in front of INTA Estación Forestal San Martín
R1) 11.Aug.1994 - R2) 12.Sep.1994 - R3) 3.Nov.1994 - R4) 27.Sep.1995

S) Argentina, Chubut, Cushamen, Epuyén, property of Ms. Ponolef
S1) 18.Aug.1994 - S2) 19.Apr.1995 - S3) 20.May.1996

T) Argentina, Chubut, Cushamen, El Desemboque, 10.Feb.1996

U) Argentina, Río Negro, El Bolsón, Loma del Medio
U1)22.Jan.1992 - U2) 10.Jun.1993 - U3) 20.Jun.1995 - U4) 5.Sep.1995 - U5) 11.May.1996

V) Argentina, Río Negro, Mallín Ahogado, 3.Nov.1994

W)Argentina, Río Negro, Mallín Ahogado, Cajón del Río Azul, 15.May.1998

X) Argentina, Río Negro, El Bolsón, Loma del Medio, stand in front of camping "Doña Rosa", 10.Jun.1998

Y) Argentina, Río Negro, Parque Nacional Nahuel Huapi, Río Manso Inferior, mixed forest of *A. chilensis* + *N. dombeyi*, 10.Apr.2000

Z) Argentina, Neuquén, Parque Nacional Nahuel Huapi, península Quetrihué, track to Seccional Arrayanes, 30.Apr.2000

RESULTS

CORTICIACEAE

Acanthophysium cerussatum (Bres.) Boidin

A3-10888, A6-11203, A7-11206, B13-11062, E2-11226; Location A, leg. C. Barroetaveña 27; Location B, leg. C. Barroetaveña s.n., 9.Apr.1991

****Aleurocystidiellum subcruentatum*** (Berk. & M.A. Curtis) P.A. Lemke

P-11948

Remarks: our specimen is totally resupinate and attached to the substrate; skeletocystidia are incrusted on all their length (cfr. Núñez & Ryvarden 1997).

Amylocorticium cebennense (Bourdot) Pouzar

A8-11212

Athelia epiphylla Pers. s.l.

F1-10871

Athelopsis aff. ***inconspicua*** (Litsch.) Jülich

B11-11022

Remarks: The specimen differs in having hyphae with thickened walls that are incrusted with crystals and resinous materials, and by somewhat smaller basidiospores 5-6 x 3.5-4 µm.

****Boidinia peroxydata*** (Rick) Hjortstam & Ryvarden

M-10917, N-11256, X-11672, X-11681

Botryobasidium obtusisporum J. Erikss.

F1-10868, N-11254; Location L, leg. MR s.n., 18.Dec.2000

Botryobasidium stigmatisporum Boidin & Gilles

H2-11155

Botryobasidium vagum (Berk. & M.A. Curtis) Rogers

K-11005, X-11653a, Y-11962

Ceraceomyces austroandinum Greslebin & Rajchenb.

B12-11039, D1-11007, E3-11238, F1-10862, F2-10879, H2-11139, H2-11152, H2-11158, H2-11170, N-11259, S3-11199, X-11653; Río Negro, Bariloche, Río Manso Inferior, leg. MR s.n., 15.Oct.1998 (BAFC 34530, holotype)

Coniophora arida (Fr.) P. Karst.

A2-10641, A2-10642, A7-11206, B2-10488, B2-10489, B2-10490, B3-10491, B4-10492, B6-10507, B13-11064, H1-10752, U2-10775, U2-10778, U3-11001, N-11255, X-11667; Río Negro, S.C. de Bariloche, leg. C. Gomez, May.1977 (BAFC 33725); Location A, leg. C. Barroetaveña, 3, Apr.1991

Remarks: one of the two species responsible for the brown saprots present in standing and fallen trees, associated with the decline of *A. chilensis*.

Crustoderma dryinum (Berk. & M.A. Curtis) Parmasto

R3-10889, X-11670, X-11679

Cylindrobasidium laeve (Pers.: Fr.) Chamuris

A6-11205, B9-10806, B11-11023, E3-11243, K-11050, O-11615, R2-10887, U4-11014, U4-11016; Location A, leg. C. Barroetaveña 21 and 23, Apr.1991

Dacryobolus sudans (Alb. & Schwein.: Fr.) Fr.

Q-12058; Location H1, leg. N. Hallenberg 12758, det. K. Hjortstam (GOT)

***Dendrothele** aff. **commixta** (Höhn. & Litsch.) J. Erikss. & Ryvarden

Chubut, Parque Nacional Los Alerces, Lago Futalaufquen, on bark and dead branchlet of standing *A. chilensis*, leg. MR s.n., 18.Dec.2000

Remarks: an immature specimen lacking crystals, but otherwise similar. Basidiospores broadly ellipsoid to obovoid, 10-12 x (7-)8-9 µm; basidia 2-sterigmate. *Dendrothele tuberculata* Greslebin & Rajchenb. is microscopically similar but the fruitbodies are calcareous, thick and with determinate margins (Greslebin & Rajchenberg 1998).

Dendrothele incrustans (Lemke) Lemke

A6-11204

Dendrothele lemkei Greslebin & Rajchenb.

E1-11219, I-11607

Dichostereum rhodosporum (Wakef.) Boidin & Lanq. vel. aff.

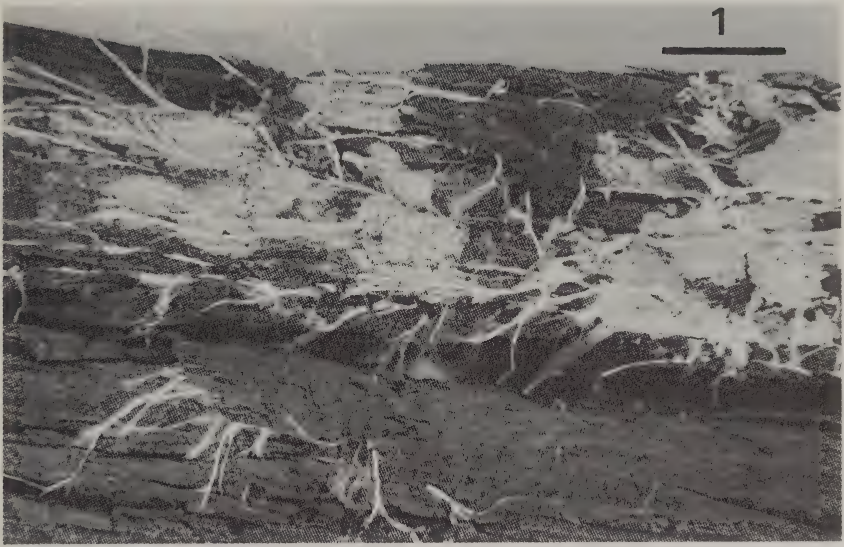
J-11174, L-10797; Chubut, Parque Nacional Lago Puelo, leg. J. Deschamps s.n., 2.Feb.1971 (BAFC 33737)

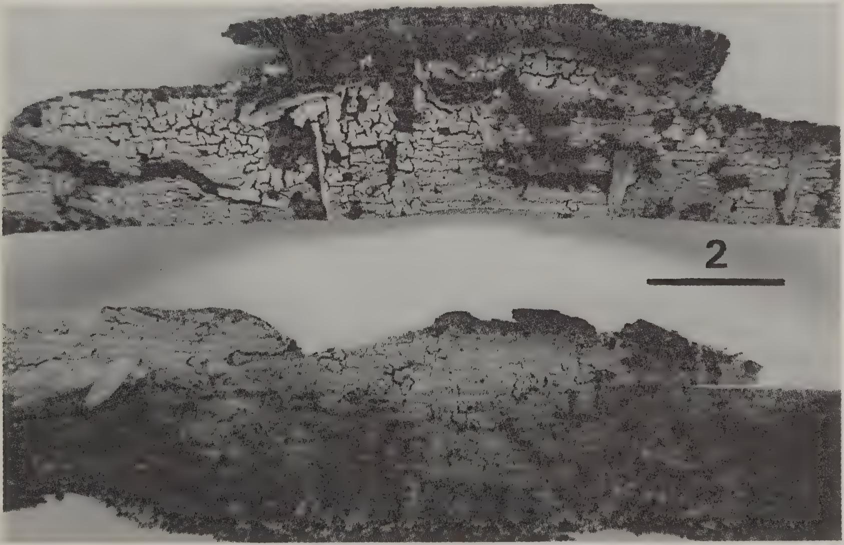
Remarks: spores are globose to subglobose, 7-8(-9) x 6.5-7.5 µm, with walls swelling in KOH, and with distinct, large warts and crests (Stalpers 1996). It differs from typical material (Boidin & Lanquetin 1980) in the presence of distinct and discernible dichophyses, and an ochraceous hymenial surface.

Fibricium gloeocystidiatum Rajchenb. sp. nov. Figs. 1, 3

Ad Fibricium rude (P. Karst.) Jülich differt hyphae gloeopleurae et gloeocystidia praesentes. Holotypus BAFC 50677.

Basidiocarp resupinate, effuse, adnate; hymenial surface cream to creamish gray, isabelline, felty to subceraceous, somewhat cracking when dried, having a pilosity due to the presence of cystidia, but sometimes easily overlooked; margin indefinite, cobwebby and/or pulverulent. Below the fruitbody under the





Figs. 1-2. Macroscopic aspect of basidiocarps. 1, *Fibricium gloeocystidiatum* sp. nov. (MR 11202). 2, *Tubulicrinis ellispoideus* sp. nov. (MR 11032). Bar = 1 cm

bark, and from the margin there is a strong development of rhizomorphs that develop in a fan-shaped manner. Subiculum thin but variable from one specimen to another, 40-100 µm thick.

Hyphal system dimitic, with clamped generative hyphae and skeletal hyphae. Generative hyphae thin to slightly thick- walled, with hemispheric clamps, (1.5-) 2-3 µm in diam. Skeletal hyphae abundant to scant or totally lacking in the subiculum; always present in the rhizomorphs and in the underlying substrate, unbranched, thick-walled, hyaline, 1.5-2 µm in diam. Gloeopleurous hyphae abundant to scant, (3-)5-7 µm in diam., present in subiculum and/or the hymenium where they form or end as gloeocystidia, with dense, homogeneous contents, sinuous, with or without constrictions.

Cystidia of two types. a) Gloeocystidia 30-60 x 5-7 µm, cylindric to clavate, rarely protruding beyond the hymenium, with contents negative in sulfobenzaldehyde that dye intensively with Cotton Blue, numerous to erratic. b) Cystidia lanceolate or cylindric fusoid, 40-80 µm long, 7-8 µm wide at the base and tapering towards the apex, that is blunt; walls thickened 0.5-0.8 µm, cytoplasm dense in the apical portion, which also has resinous exudates that may be difficult to observe, as they disappear in the mounting liquid.

Basidia clavate, 11-14 x 3-4 µm.

Basidiospores cylindric, ellipsoid to ovoid, 4.5-5 x 2-2.5(-3) µm, thin-walled, IKI-, some agglutinated around the lanceolate cystidia.

Habitat: on fallen branches, trunks and wood of *A. chilensis*, fruiting on the bark and wood.

Type: ARGENTINA, Chubut, Futaleufú, Los Cipreses, Estancia Pehuén, leg. M. Rajchenberg 11218, 15.Mar.1997 (BAFC 50677).

Other material studied: ARGENTINA, Chubut, Futaleufú, Los Cipreses, Estancia Pehuén, leg. M. Rajchenberg 11216, 15.Mar.1997. Los Cipreses, Trevelin, Estación Agroforestal INTA, leg. ipse 11201, 20.Nov.1996. Ibid., leg. ipse 11202, 7.Dic.1996. Ibid., leg. ipse 11208, 11.Feb.1997. Ibid., leg. ipse 11211, 6.Mar.1997. Ibid., leg. C. Barroetaveña 12, Abr.1991.

Reference material of Fibricium rude: CANADA, BC, Yoho National Park, S of Takakkaw falls, on fallen log of *Abies lasiocarpa*, leg. L. & N. Hallenberg NH-6682, 20.Aug.1982 (GB 639). SWEDEN, Västergötland, coniferous forest near Storemossen, leg. K. Hjortstam, T. Hallingback & S. Jacobsson KH-7165, ep.1976.

Remarks: the species is similar in most respects to *Fibricium rude* (P. Karst.) Jülich, but differs in the presence of gloeopleurous hyphae and gloeocystidia. The spores are somewhat wider when compared with North European materials of *F. rude*, that have narrowly to subcylindric spores, 4.5-5.5 x 1.2-2 µm (Eriksson & Ryvarden 1975), but are similar to North American specimens, which are short cylindric, 4.5-5 x 2-2.5 µm (Gilbertson 1974). Skeletal hyphae may be overlooked in some specimens, as they may be absent in the subiculum and lead to a misconception of the hyphal system, that may be regarded as monomitic. The confusion with *Hyphodontia hastata* (Litsch.) J. Eriks. is not unexpected, then, as is also the case with *F. rude* (K. Hjortstam, pers. com.).

Gloeocystidiellum porosum (Berk. & M.A. Curtis) Donk vel aff.

H1, leg. N. Hallenberg 12766 (GOT) det. K. Hjortstam, K-11049

Remarks: the specimens are characterized by thick-walled gloeocystidia and may represent a new taxon (K. Hjortstam, pers. com.).

Hyphoderma argillaceum (Bres.) Donk

C-11194, H3-11581, R4-11033, W-11646, W-11649

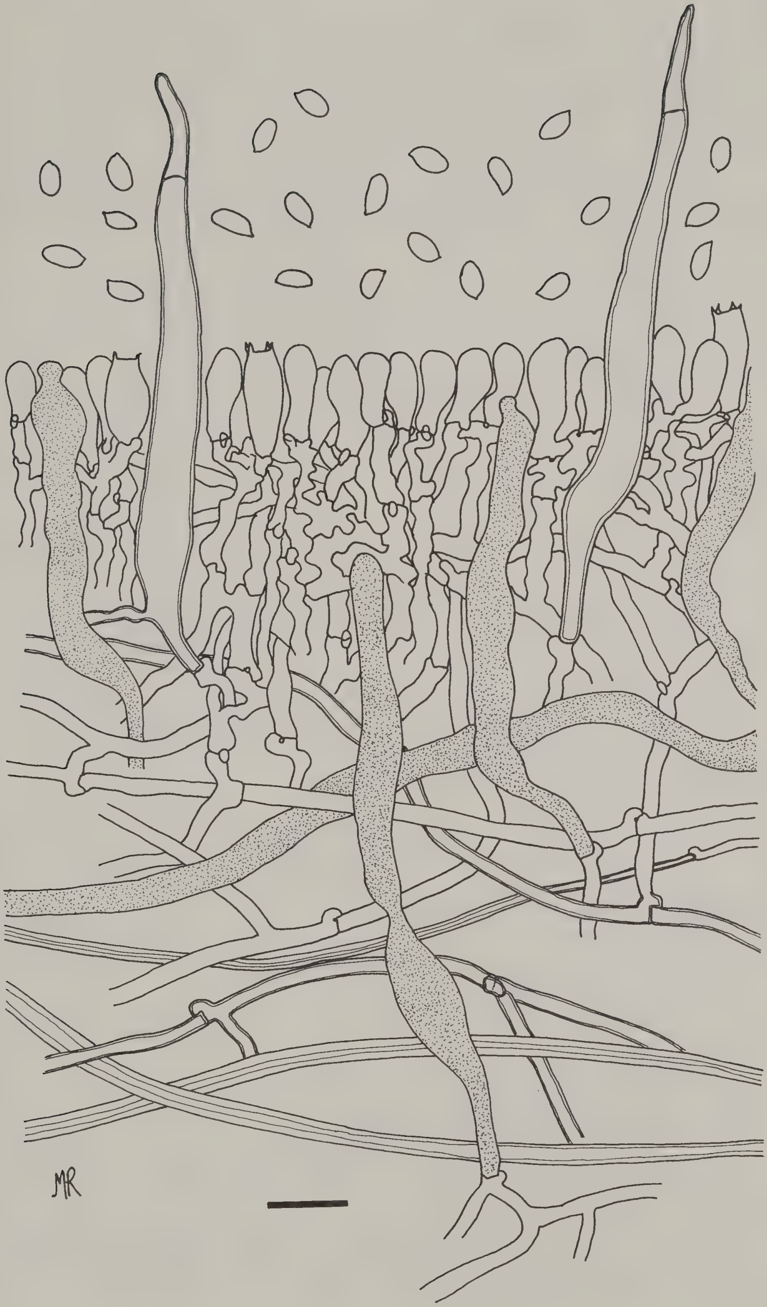


Fig. 3. *Fibricium gloeocystidiatum* sp. nov. Cross section of basidiocarp. Bar = 10 µm.

Hyphoderma aff. ***cremeoalbum*** (Höhn. & Litsch.) Jülich

H2-11140

Remarks: material is scant

******Hyphoderma echinocystis*** J. Erikss. & Å. Strid

X-11683

Remarks: a strange finding but otherwise similar to the original description, found in a very humid environment on a fallen trunk.

Hyphoderma praetermissum (P. Karst.) J. Erikss. & Strid

B11-11019b, B12-11040, R4-11028

Hyphoderma puberum (Fr.) Wallr.

F1-10870, M-10916; Location A, leg. C. Barroetaveña 11, Apr.1991; Chubut, Parque Nacional Los Alerces, southern entrance, ca. former Futaleufú river bed, on a fallen trunk by a stream near camping El Mirador, leg. MR s.n., 13.Jan.2000

Hyphoderma sibiricum (Parmasto) J. Erikss. & Å. Strid vel aff.

H1, leg. N. Hallenberg 12759, on fallen branch (GOT).

Remarks: the species was previously recorded from Argentina by Galán et al. (1993).

Hyphodontia alutaria (Burt) J. Erikss.

X-11655

Hyphodontia arguta (Fr.) J. Erikss.

A8-11215, B1-10485, B10-10918, B13-11065, O-11616, O-11620, U4-11011W-11648, X-11657

Hyphodontia crustosoglobosa Hallenb. & Hjortstam

A7-11207, Location B, leg. C. Barroetaveña 42, 9.Apr.1991, E3-11246, H2-11146, H2-11147, H2-11154, H2-11163, H2-11164, H2-11167, I-11603, P-11950

Hyphodontia gamundiae Greslebin & Rajchenb.

B1-10484, E3-11244, F1-10866, F1-10867, F2-10878, H3-11583, I-11600, J-11177, J-11183, T-11066; Location C, leg. MR s.n., 15.Oct.1995, on decayed trunk; Chubut, Parque Nacional Lago Puelo, leg. J. Deschamps, 2.Feb.1971 (BAFC 33739)

Hyphodontia magnifica Greslebin & Rajchenb.

K-11059

Hyphodontia nesporina Hallenb. & Hjortstam

E2-11223, E2-11224, E2-11227, E3-11233, E3-11236, F1-10872, H2-11166, I-11599, I-11601, I-11606, I-11609, I-11612, K-11047, R2-10887, R3-11030, R4-11031, Y-11960; Location B, leg. C. Barroetaveña 35 and 36, 9.Apr.1991

Hyphodontia pruni (Lasch.) Svrcek vel aff.

H3-11593, S2-10983

Hyphodontia sambuci (Pers.: Fr.) J. Erikss.

Location B, leg. C. Barroetaveña 37, 1.Oct.1995

Hyphodontia spathulata (Schard.: Fr.) Parmasto

R2-10886

Hyphodontia subalutacea (P. Karst.) J. Eriksss.

Location A, C. Barroetaveña 14, Apr.1991

******Leptosporomyces galzinii*** (Bourdot) Jülich

B11-11019, B13-11063, K-11057, X-11659

Remarks: the specimens have crystals on the hyphae, the hymenial surface is white and never develops greenish hues.

Melzericium udicola (Bourdot) Hauerslev

Río Negro, El Bolsón, Loma del Medio, track to Cabeza de India, leg. N. Hallenberg 12733, 18.Mar.1993 (GOT)

Peniophora lycii (Pers.) Höhn. & Litsch.

A8-11210

Phanerochaete velutina (DC.:Fr.) P. Karst.

I-11602, K-11054, K-11055, P-11952, W-11650, X-11664, Y-11260; Location a, leg. C. Barroetaveña 6, Apr.1991

Phlebiella aff. ***christiansenii*** (Parmasto) K.H. Larss. & Hjortstam

B11-11020, A5-11200

Phlebiella tulasnelloidea (Höhn. & Litsch.) Oberw.

H2-11151, K-11052; Location A, leg. C. Barroetaveña 11, Apr.1991; Chubut, Parque Nacional Lago Puelo, leg. J. Deschamps s.n., 2.Feb.1971 (BAFC 33740)

Scytinostroma ochroleucum (Bres.& Torrend) Donk

F1-11241, H2-11153, H3-11580, H3-11582, H3-11592, H3-11595, H3-11597, J-11176, J-11181, J-11182, N-11252, X-11680

Sistotrema brinkmanii (Bres.) J. Erikss.

Remarks: isolated from decayed wood (Barroetaveña & Rajchenberg 1996).

Sistotremella perpusilla Hjortstam

H1, leg. N. Hallenberg 12767, det K. Hjortstam (GOT)

Steccherinum fimbriatum (Pers.: Fr.) J. Erikss.

H3-11590

Trechispora cohaerens (Schw.) Jülich & Stalpers

B4-10494, E3-11242; Neuquén, Parque Nacional Nahuel Huapi, head of arm Huemules, leg. MR s.n., 22.Oct.1996

Trechispora farinacea (Pers.:Fr.) Liberta

I-11610, X-11663, Y-11959; Location B, leg. MR s.n., 20.Oct.1995

****Trechispora praefocata*** (Bourdont & Galzin) Liberta

R4-11035, V-10891, X-11669

****Tubulicrins chaetophorus*** (Höhn.) Donk

H3-11587, N-11262

Tubulicrinis glebulosus (Bres.) Donk

A8-11213, E2-11225, F1-10873, N-11253; Chubut, Futaleufú, Los Cipreses, leg. MR s.n., 29.Apr.1998; Ibid., leg. C. Barroetaveña 43, 9.Apr.1991

Tubulicrinis ellipsoideus Greslebin & Rajchenb. sp. nov. Figs. 2, 4

Jacens, adnato, laevis, poruloso vel denso, margo mycelioide et indeterminato. Hyphae generativae fibulatae. Lyocystidiis cylindraceis, inamyloideis, 55-120 µm longo, in basim 12 µm lato, in subapicem 6-7 µm lato, apicem dilatatum 7-9 µm. Basidia clavata 16-25 x 7-10 µm. Basidiosporis ellipsoideis, 8-10 x (4.5-)5-6 µm, tenuitunicatis, hyalinis. Holotypus BAFC 50678.

Basidiocarp resupinate, adnate, thin, openly to more or less densely felty, margin indeterminate, cobwebby to somewhat farinose. Hymenial surface smooth, under the lens porulose to close and dense, hispid because of the cystidia, white, cream to light beige, cracking with age or not.

Hyphal system monomitic. Generative hyphae clamped, with hyaline, thickened walls, 2-3 µm diam.

Lyocystidia cylindric, slightly expanded but indistinctly capitate, bi-radicate, seated on the substrate, inamyloid, with homogeneously thickened walls, 55-120 µm long, to 12 µm wide at the base, 6-7 µm wide below the apex, the latter widened to 7-9 µm, thin walled and irregularly incrusted.

Basidia clavate, 16-25 x 7-10 µm, with thin to slightly thickened walls, with 4 sterigmata.

Basidiospores ellipsoid, 8-10 x (4.5-)5-6 µm, thin-walled, IKI -.

Type: Argentina, Neuquén, Los Lagos, Villa La Angostura, Cerro Bayo, on fallen trunk of *Nothofagus pumilio*,leg. A. Greslebin 1256, 29.Oct.1997 (BAFC 50678).

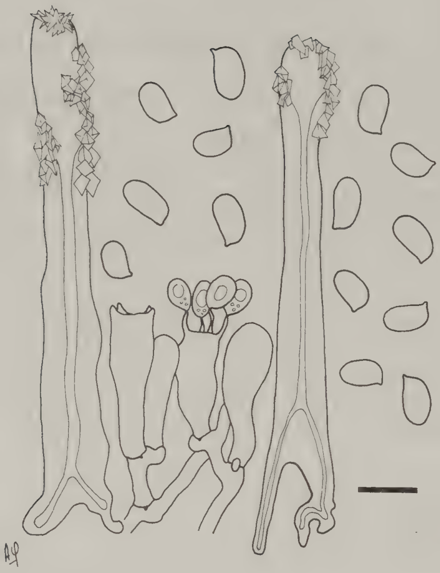


Fig. 4. *Tubulicrinis ellipsoideus* sp. nov. Microscopic features, lyocystidia, spores and basidia. Bar = 10 µm.

Other material studied: Argentina, Chubut, Cushamen, Golondrinas, stand of *Austrocedrus chilensis* in front of Estación Forestal INTA Gral. San Martín, on fallen trunk of *A. chilensis*, leg. M. Rajchenberg 11032, 27.Sep.1995. Neuquén, Maipú, CORFONE Lote 43, on fallen trunk of *N. pumilio*, leg. A. Greslebin 1293, 3.Nov.1997.

Remarks: the new species is distinguished on account of its rather large, wide and ellipsoid spores, and the features of the lyocystidia. Other species with ellipsoid spores have either smaller or narrower spores and lyocystidia are different in shape. It comes close to a *Tubulicrinis* sp. described from the Reunion Is. by Boidin & Gilles (1988), which differs by cylindric, slightly narrower and phaseolate spores, 7-8(-9) x 3.75-4.2 µm, but is similar in the lyocystidial features. All the materials studied are rather scant but otherwise typical and the type is fertile and has plenty of spores.

POLYPORACEAE

Antrodia sp.

Basidiocarp resupinate to effuse-reflexed, pores 2-2.5 /mm, roundish, angular or sinuous, hymenial surface beige, light ochraceous, pore mouths white, tubes to 1-2 mm long.

Hyphal system dimitic. Generative hyphae dominating in the whole fruitbody, with hyaline, IKI-, irregularly thickened walls, except in the pore mouths and subhymenium, where they are thinwalled. Skeletal hyphae scant, unbranched, solid, restricted to the context against the substrate.

Basidiospores cylindric to fusiform, 7-8-9 x (2-)2.5-3 µm.
Basidia claviform, 20-25 x 6-8 µm.
Cystidia absent.
Material studied: Chubut, Parque Nacional Lago Puelo, track from La Playita to Mt. Currhumahuida, 230 m asl, on bark of fallen trunk of *A. chilensis* in mixed forest of *A. chilensis* + *Nothofagus dombeyi*, leg. A. Vidoz, 21.Jul.2000. Neuquén, Parque Nacional Lanín, seccional Tromen, on fallen branch and trunk of *Araucaria araucana*, leg. MR 11937, 20.May.1999.

Remarks: a new addition to the polypore flora of Argentina (Rajchenberg 2001), but its identification is still uncertain because of the scant material. The specimens come close to *Antrodia serialis* (Fr.) Donk and *A. sinuosa* (Fr.) P. Karst., which differ by the abundance of skeletal hyphae throughout the basidiocarp and, the latter species, also by having smaller spores. According to Dr. P. Renvall (pers. com.) it comes close to *A. primaeva* Renvall & Niemelä and *A. infirma* Renvall & Niemelä, other species with a poor development of skeletal hyphae, but both species only exhibit thin-walled generative hyphae.

Bjerkandera adusta (Willd.: Fr.) P. Karst.
B7-10699, S3-11189

Fibroporia vaillantii (DC.: Fr.) Parmasto
X-11674; Río Negro, El Bolsón, leg. E. Varsavsky 22, Jan.1975 (BAFC 23804)

Gloeophyllum abietinum (Bull.: Fr.) P. Karst.
Q-12055, R1-10880, R1-10881, R2-10884, R3-10890, R4-11027, S3-11190, U5-11191, W-11651, X-11660

Gloeophyllum trabeum (Pers.: Fr.) Murrill
B11-11018, B12-11037, D1-11006, Q-12066; Chubut, Parque Nacional Los Alerces, southern border of the park, Río Futaleufú, leg. MR s.n., 18.Aug.2000; Parque Nacional Lago Puelo, occidental slope of Mt. Currhumahuida, above Puntilla de Las Papas, 290 m asl, leg. F. Vidoz, 29.Aug.2000.

Perenniporia medulla-panis (Jacq.: Fr.) Donk
F-12047
Remarks: previously isolated from a heart-rot in a fallen trunk (Barroetaveña & Rajchenberg 1996).

Polyporus melanopus Sw.: Fr.
B2-10700, X-11654, X-11666, X-11169; Location W, leg. MR s.n., 15.May.1998 (3 collections)

Postia caesia (Schrad.: Fr.) P. Karst.
H3-11596, K-11060, U3-10999, Z-12008

Postia dissecta (Lév.) Rajchenb.
A1-10464, A2-10637, A2-10638, A2-10637, A2-10638, B1-10480, B1-10481, B1-10482, B1-10483, B4-10493, B4-10494, U1-10502, U2-10776, U2-10778, G-10780
Remarks: a frequent species found on standing and fallen trees, and responsible for the brown saprots found in declining *A. chilensis* (Barroetaveña & Rajchenberg 1996).

Postia rennyi (Berk. & Br.) Rajchenb.
B4-10497, U2-10773, X-11661, X-11671

Schizopora radula (Pers.: Fr.) Hallenb.
S2-10982, X-11668; Location A, leg. C. Barroetaveña 8, Apr.1991

Trametes versicolor (L.: Fr.) Lloyd
K-11056, S3-11188

Tyromyces merulinus (Berk.) G. Cunn.

B1-10478, B8-10759, E2-11222, E3-11239, E3-11240, H2-11150, I-11611, J-11184, K-11053, R2-10885, R4-11024, R4-11025, X-11662, X-11675

DISCUSSION

Austrocedus chilensis proved to be a rather poor substrate for aphyllophoraceous fungi, with 52 corticioid and 13 polyporoid taxa so far found. Many of the records consisted of single or few (n≤3) specimens found in one location, pointing to a poor capacity of these fungi to grow and/or develop on this substrate. Certainly, ecological features may account for this fact: many areas covered by *A. chilensis* receive a low amount of precipitation and, even in areas with good precipitation rates, it falls at the end of autumn or in winter, when low temperatures prevent fungal growth. A special effort was made in order to find the fungal agent responsible of the central and excentric, white heartrots found in this conifer, which is presumably a Hymenochaetaceae as determined through cultural features (Barroetaveña & Rajchenberg 1996). Nevertheless, the search was unsuccesfull, in spite that humid areas in the west were visited. The present list is preliminary, since other species will probably be found when more northern areas in Patagonia are visited. The finding of some species not recorded by Greslebin (2001) on *Nothofagus pumilio* and other woody substrates is not unexpected, providing the particular environment and habitat of *A. chilensis*.

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MOLECULAR IDENTIFICATION OF THE TELEOMORPH OF BEAUVERIA BASSIANA [*]

BO HUANG [1, 2], CHUN-RU LI [2], ZHEN-GANG LI [1],

MEI-ZHEN FAN [2], ZENG-ZHI LI [2**]

①School of Life, University of Science & Technology of China, Hefei, Anhui, China, ②Research Institute of Economic Insects & Fungi, Anhui Agricultural University, Hefei, Anhui, China.

**Corresponding author, Email: zzliaau@163.net

ABSTRACT

Beauveria bassiana, which is widely used in insect pest biocontrol, is one of the most common species of entomopathogenic fungi. This species is widely distributed as an anamorph and a potential teleomorph has only recently been identified. The genes of the 5.8S rRNA and the complete internal transcribed spacer (ITS) regions from *Cordyceps bassiana* and *B. bassiana*, isolated from this *Cordyceps* specimen, were sequenced and compared in this study. The results showed that *C. bassiana* and *B. bassiana* have the same ITS_1-5.8S-ITS_2 nucleotide sequences, which strongly supports the fact that *C. bassiana* is the teleomorph of *B. bassiana*. Molecular phylogenetic analysis demonstrated that the conidial isolate of *C. bassiana* belongs to the widely distributed *B. bassiana* species complex.

KEY WORDS: Entomopathogenic fungi, *Cordyceps bassiana*, ITS_1-5.8S-ITS_2 region.

INTRODUCTION

Entomopathogenic fungi are being used for the control of many insect pests as an environmentally acceptable alternative to chemical insecticides (Charnley, 1991). Among them, *Beauveria bassiana* (Balsamo) Vuillemin, is one of the most familiar species in the group of mitosporic or asexual entomophthogenic fungi. Because of its

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wide distribution and being able to infect about 700 species of insect or mites belonging to 16 orders (Li, 1988), it is widely used as a biological control agent for agricultural and forest insect pest management in many countries. In China, it has been mass-produced in metric tons and applied in large scale against Masson's pine caterpillar, *Dendrolimus punctatus* (Walker), making this one of the largest, successful microbial pest control programs in the world.

It has been hypothesized by Arx (1986) and Samson *et al.* (1988) that the teleomorphic forms of *Beauveria* would belong to the genus *Cordyceps*. In 1988, *Beauveria brongniartii* (Sacc.) Petch was the first species in the genus *Beauveria* that was reported to be an anamorph of a species in the genus *Cordyceps*. Subsequently, its perithecial stromata were artificially cultured (Shimazu *et al.*, 1988). Five years later, the natural stroma of *C. brongniartii* were found in China (Liu and Liang, 1993). However, the teleomorph of *B. bassiana*, the most common and important insect pathogen, remained uncertain until Li *et al.* first reported that *Cordyceps bassiana* Z.Z. Li, C.R. Li, B. Huang & M.Z. Fan was the teleomorph for *B. bassiana* (Li *et al.*, 2001). Before the teleomorph of *B. bassiana* was found in China, most researchers hypothesized that it completely lacked a conventional sexual cycle but instead engaged only in genetic recombination through parasexual cycles.

The DNA sequences that encode ribosomal RNAs have been publicly recognized as powerful molecular tools to clarify the relationships between ascogenous state species and conidial state species. rDNAs have been extensively used to study the taxonomic relationships and genetic variations in fungi. The internal transcribed spacers (ITS) are more variable than the subunit sequences, and many reports have employed them for analysis of the relationships among species within a single genus or among intraspecific populations. In the genus *Beauveria,* the ITS_1-5.8S-ITS_2 regions of six isolates of *B. brongniartii* and one isolate of *B. bassiana* were sequenced by Neuveglise *et al.* (1994) and the data surprisingly showed intraspecific variability due to point mutations in ITS_1 (0.7-14.7%) and ITS_2 (1.8-16.7%). A complete sequence for the ITS_1-5.8S-ITS_2 region for two isolates of *B. bassiana* was published by Shih *et al.* (1995) and additional sequences for comparison were found in GenBank.

The goal of this study was to determine the connection between *B. bassiana* and *C. bassiana* by sequencing the ITS_1-5.8S-ITS_2 region of stroma of *C. bassiana* and a culture from its conidial isolate. We also studied whether Chinese collections of the teleomorph should be included in the clade of the *B. bassiana* species complex.

MATERIALS AND METHODS

Fungal isolates

A *C. bassiana* specimen (ST000903-02) was collected from an insect cadaver in decayed wood at the National Nature Conservation of Guniujia, Shitai County, Southern

Anhui, China, and its host was identified as a carpenterworm (Lepidoptera: Cossidae). *B. bassiana* (RCEF0771) was isolated from ascospores discharged onto glass slides.

DNA preparation

A fruiting body of the type specimen and mycelia of *B. bassiana* scraped from the medium were finely ground under liquid nitrogen, and genomic DNA was extracted by use of $PhCH_2Cl$ according to the method of Zhu *et al.* (1994). The extracted DNA was stored in 100μl TE buffer (10mM Tris-HCl, PH8.0; 1mM EDTA) at 4℃, and DNA solutions were diluted 10-fold with TE for use in PCR reactions.

PCR amplification

The nuclear ITS_1-5.8S-ITS_2 regions were amplified with a primer pair described by Mavridou and Types (1998). The PCR reactions were performed in 50μl volume with the following components: 10mM Tris-HCl (PH8.3), 50mM KCl, 2mM $MgCl_2$, 0.001% gelatin, 200μM of each dNTP, 20-100ng genomic DNA, 12 pmole of each primer, and 2.5 units Taq DNA polymerase (Sangon, China). The reactions were prepared on ice in 500 μl microcentrifuge tubes, overlaid with 20 μl mineral oil, and placed in a thermal cycler (Techine, UK). Cycling parameters were programmed as following: an initial denaturation at 95℃ for 3 min, followed by 35 cycles of denaturation at 94℃ for 1 min, annealing at 54℃ for 1 min and extension at 72℃ for 2 min, with a final extension at 72℃ for 10 min. Efficiency of amplification was monitored by running 8 μl of each product through 1.2 % agarose gels using TAE buffer and visualizing with ethidium bromide.

Purification of amplification products

Amplification products were purified by use of a Wizard™ PCR Preps DNA Purification System kit (Promega Co., France) based on the methods provided by the company.

DNA cloning and sequencing of amplified ITS region

Purified ITS PCR products were cloned into T-Vectors, which were prepared by ourselves from SK plasmids. This vector was used to transform *Escherichia coli* XL1-Blue and the plasmid DNA was extracted using an alkaline lysis method (Sambrook *et al.*, 1989).

The primers T7/T3 (forward and reverse) were used to sequence both strands using the dideoxy-nucleotide chain termination on an ABI 3700 automated sequencer at Shanghai Genecore Biotechnologies Company. Sequence data of *C. bassiana* (ST000903-02) and *B. bassiana* (RCEF0771) have been submitted to the Genome Sequence Data base (Accession No. AF347612 and AF347611, respectively) and have been compared with all available ITS sequences of *B. bassiana* retrieved from the GenBank Nucleotide database.

Alignments and analysis

Sequences were aligned with Clustal W (Thompson *et al.*, 1994) and positions with gaps are excluded. A phylogenetic tree was constructed using neighbour-joining methods with bootstrap values for 100 replicates. The program used was TreeconW in the Treecon software package.

RESULTS

The taxonomic placement of the conidial isolate of *Cordyceps bassiana* in *Beauveria bassiana* species complex

To determine the phylogenetic position of *C. bassiana* in the *B. bassiana* species complex, the sequence of the strain (RCEF0771) (Genbank Accession No. AF347611) was analyzed by clustering with the sequences of 26 strains of *B. bassiana*, 1 strain of *B. brongniartii*, 1 strain of *B. amorpha* and 1 strain of *B. alba* (Fig1). The results demonstrated that great genetic variability existed among the 26 strains of *B. bassiana*, which can be divided into 3 clades (Clade 1, Clade 2, Clade 3). The conidial isolate of

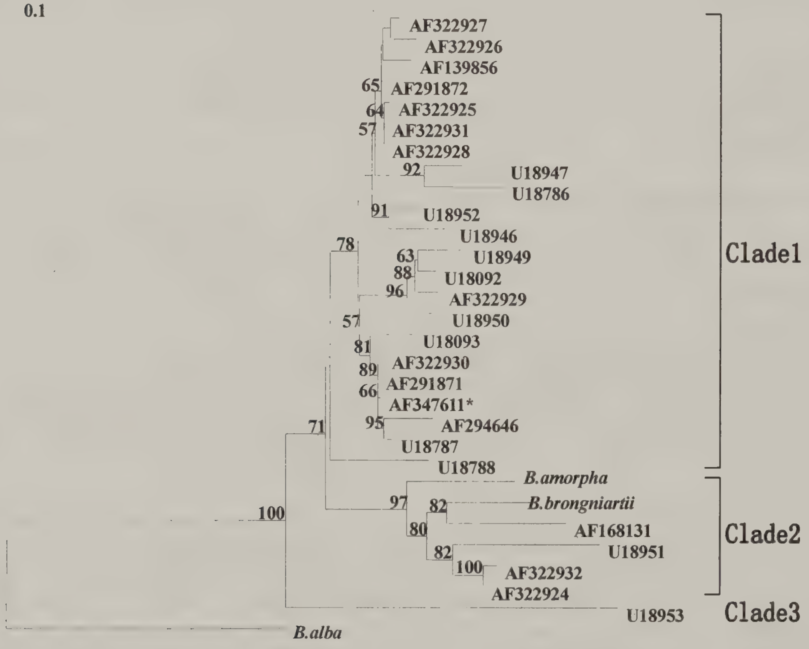
0.1
AF322927
AF322926
AF139856
65
AF291872
64
AF322925
57
AF322931
AF322928
92
U18947
U18786
91
U18952
U18946
78
63
U18949
88
U18092
96
AF322929
57
U18950
81
U18093
89
AF322930
66
AF291871
AF347611*
95
AF294646
71
U18787
U18788
B.amorpha
97
82
B.brongniartii
100
80
AF168131
82
U18951
100
AF322932
AF322924
U18953
B.alba
Clade1
Clade2
Clade3

Fig.1 Neighbour-joining tree based on ITS_1-5.8S-ITS_2 region sequence data from *Beauveria* spp. Numerical values above the branches indicate bootstrap percentiles from replicates. (AF×××××× or U××××× is GenBank Accession No., and stands for different strains of *B. bassiana*)

C. bassiana was grouped in Clade 1 which included only isolates of *B. bassiana* and is speculated as being the widely distributed *B. bassiana* species complex.

There were 4 strains of *B. bassiana*, 1 strain of *B. brongniartii* and 1 strain of *B. amorpha* in Clade 2, which indicates that the morphological characters in the genus *Beauveria* are unreliable. In particular, the distinction between *B. bassiana* and *B.brongniartii* is not supported. Our molecular and morphological evidence in this study proved that the conidial isolate of *C. bassiana* does not belong to the anamorphs *B. brongniartii* or *B. amorpha*.

The sequence data for U18953 is substantially different from that of the strains in Clade 1 and Clade 2, and therefore, U18953 forms Clade 3.

Relationships between *Beauveria bassiana* and *Cordyceps bassiana*

A total size of the ITS_1-5.8S-ITS_2 region (482 bp) for *C. bassiana* (GenBank Accession No. AF347612) was identical with that of *B. bassiana* after sequencing. The sizes of ITS1, 5.8S and ITS2 in the ITS_1-5.8S-ITS_2 region are 161 bp, 151 bp, 170 bp, respectively. The alignment showed that *C. bassiana* and *B. bassiana* isolated from this *Cordyceps* specimen had the same ITS_1-5.8S-ITS_2 sequences, and that the percentage of nucleotide divergence was 0%. This indicates that *C. bassiana* and *B. bassiana* in this study were genomically identical. This molecular evidence proved that the teleomorph of *B. bassiana* is *C. bassiana*.

DISCUSSION

The insect pathogenic fungus *B. bassiana* is one of the most common and important species among the entomogenous fungi. As for its teleomorph, Schaeffenberg (1955) once reported about the discovery of its ascogenous state, but due to lack of detailed information this identification proved to be invalid. Booth claimed that the asexual state of *Pseudeurotium bakeri* (Ascomycotina: Plectomycetes), isolated from fresh tunnels of ambrosia beetles, was supposed to be the anamorph of *Beauveria*, probably *B. bassiana* (Booth, 1961). He found collateral evidence that the conidial state of the very closely related *Cephalotheca savoryi* was close to *Tritirachium*, a genus closely related to *Beauveria*, since *B. alba* was originally attributed to *Tritirachium* (Hoog, 1971). No teleomorph has been suggested for *B. bassiana* apart from these two reports. The connection between *B. bassiana* and *C. bassiana* was recently established in our laboratory based on the microcycle conidation of secondary ascospores (Li *et al.*, 2001). The primary results indicated that *C. bassiana* is the teleomorph of *B. bassiana.* The present molecular biological evidence confirms our previous results.

It has been difficult for researchers to determine the anamorphic states of *Cordyceps* for a long time. According to Koch's postulate, stromata production by inoculating the conidia of the anamorph on host insects would be the most authoritative method. However, it proves to be very hard to get fruiting bodies of *Cordyceps* from artificial cultures. Five criteria for determining the anamorph of *Cordyceps* were suggested by Kobayasi (1941) based on summarizing the former work; these proved to be practical but not reliable. Liang (1991) put forward the determination method by microcycle conidiation of secondary ascospores, which is desirable and reliable. However, it is difficult to optimize proper conidiation conditions and it is impossible when using older specimens from which ascospores were not isolated in time.

Molecular biology, with the rapid development of molecular techniques, has gradually been employed to determine the anamorphs of *Cordyceps*. Li *et al.* (2000) studied the relationships between *Hirsutella sinensis* Liu, Guo, Yu & Zeng and *Cordyceps sinensis* (Berk.) Sacc. using RAPD-PCR analysis, and confirmed that *H. sinensis* was the anamorph of *C. sinensis*. Zhao *et al.* (1999) sequenced and compared the ITS1 from *C. sinensis, H. sinensis*, and *Paecilomyces sinensis* Chen, Xiao & Shi, and concluded that the asexual stage of *C. sinensis* is not *P. sinensis* but *H. sinensis*. We recently studied the taxonomic status of *Metarhizium taii* and the connections between *Cordyceps taii* Liang & Liu and *M. taii* Liang & Liu by sequencing the ITS_1-5.8S-ITS_2 region. The molecular evidence showed that *M. taii* should be treated as a synonym of *M. anisopliae* (Metsch.) Sorokin var. *anisopliae*, and the teleomorph of *M. taii* is *C. taii* (unpublished). In this study, *C. bassiana* and *B. bassiana* isolated from this *Cordyceps* specimen had the same ITS_1-5.8S-ITS_2 sequences, which strongly supports that *C. bassiana* is the teleomorph of *B. bassiana*. The above results show that the anamorph of *Cordyceps* was correctly determined through the use of molecular techniques. The similarity of the DNA fingerprinting patterns between the stroma of *Cordyceps* and the supposed anamorph can be compared employing molecular techniques, e.g., RAPD or AFLP, ITS or IGS sequences, etc.

The morphological differences between *Cordyceps* and its different anamorphs are supposed to be caused by differential expression of mRNAs during the sexual and asexual stage, and they should be genomically identical. No strains of *B. bassiana* that are able to develop stroma have been reported previously apart from two strains from China, and actually, no stromata have been developed on artificial media by inoculating conidia of the strain (RCEF0771) during our studies. The conditions that lead to production of natural and artificial stromata are still unknown, and further studies are clearly needed.

Based on our molecular analysis, the differences among Clade 1, Clade 2 and Clade 3 are speculated as interspecific differentiation, which suggests that *B. bassiana* is a species complex. Genetic variation among different isolates of *B. bassiana* from diverse geographical locations and insect hosts was studied by some researchers using isozyme analysis, RAPD and RFLP techniques. The results indicated that *B. bassiana* is an aggregate species (Leger *et al.*, 1992; Maurer *et al.*, 1997; Glare and Inwood, 1997). RAPD studies of *M. anisopliae* have also shown high levels of genetic heterogeneity among strains (Cobb and Clarkson, 1993; Bidochka *et al.*, 1994; Leal *et al.*, 1994). Driver *et al.* (2000) finally resolved the species complex into five varieties based on sequencing ITS regions of many isolates, and most of the isolates belong to *M. anisopliae* var. *anisopliae* which is world-wide in distribution. Further work is needed to analyze ITS sequences of *B.bassiana* strains from various geographic origins to resolve taxonomic relationships within this species complex.

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PLECTANIA CARRANZAE SP. NOV. (ASCOMYCOTINA) FROM COSTA RICA

F. D. Calonge[1] and M. Mata[2]

[1]Real Jardín Botánico, CSIC, Plaza de Murillo 2. 28014 Madrid, Spain
[2] INBio, Instituto Nacional de Biodiversidad, A. P. 22-3100, Santo Domingo, Heredia, Costa Rica

ABSTRACT

Plectania carranzae is described and proposed as a new species on the basis of its distinct macro- and microscopic characters.

Key words: Sarcosomataceae, taxonomy, Central America.

INTRODUCTION

The genus *Plectania* was proposed by Fuckel (1869) and later emended by Saccardo (1884). In this paper we follow the genus concept expressed by Korf (1970, 1972) and Paden (1983).

During the elaboration of this paper we hesitated whether accepting or not the genus *Pseudoplectania* Fuckel as valid. Its distinction from *Plectania* is only based on having spherical spores. Moreover, simultaneously, we received valuable information from Korf (pers. comm), telling us how *Plectania* and *Pseudoplectania* share the same anamorph, *Conoplea* Pers., and, at the same time how DNA sequencing in both genera does not reveal significant differences. Thus, we are totally convinced that *Plectania* and *Pseudoplectania* are synonyms.

As a result of the study of Pezizales from Costa Rica, deposited in the School of Biology, University of Costa Rica, INBio and National Museum herbaria, we found a collection which did not match up to any of the already described species of *Plectania*. We have decided to propose it as a new species.

DESCRIPTION

Plectania carranzae Calonge & Mata, **sp. nov.** (figs. 1-3)
Etym.: carranzae, dedicated to the eminent Costarican mycologist Julieta Carranza, for her contribution to the study of the mycoflora of Costa Rica.

Diagnosis: Ascomata 5-20 mm diam, gregaria, atra, cyathiforme-discoidea, stipitata. Asci octospori, cylindracei, 170-200 x 10-14 µm, monoseriati. Paraphyses luteae, septatae, curvatae ad apicis, raro ramosae, 3-4 µm diam. Ascosporae sphaericae, laeviae, 11-13 µm diam. Excipulum medulare textura intricata, cum hyphae hyalinae, 3-4 µm diam. Excipulum corticale textura globulosa ex cellulis nigris compositum, 8-10 µm diam, cum tomentum hyphae curvatae usque 200 µm longae et cum hyphae rectae usque 4000 µm longae ad stipitae tomentum compositum et subiculum supra superficies substratae.

Holotypus: *Costa Rica, Area Conservación La Amistad Pacífico, Fila Chiquizá,ad lignum, 21-XI-2000, leg. M. Mata.* INB 0003300141.

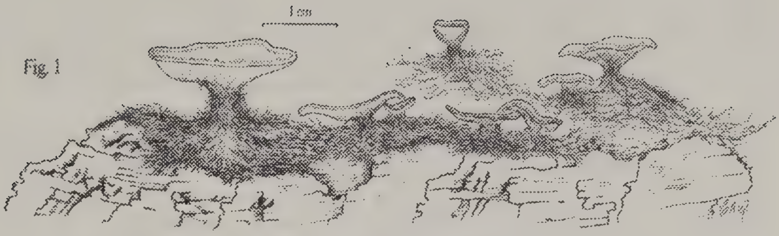
Ascomata black, 5-20 mm diam, gregarious, cyathiform becoming discoidal, with a stalk, 1-5 mm high (fig. 1), rarely absent, covered by long black hairs. Hymenium surface smooth, but outer surface covered by long black tomentum hyphae, which are less abundant upward. *Asci* cylindrical, 170-200 x 10-14 µm, 8-spored uniseriate non-amyloid (fig. 2). *Paraphyses* filiform, 3-4 µm diam, curved at the apices, septate, branched at times, pale yellowish (fig. 2). *Spores* spherical, 11-13 µm diam, smooth, non-amyloid with a wall 2-3 µm thick (fig. 2). *Medullary excipulum* of textura intricata, made of hyaline hyphae 3-4 µm diam (fig. 3-A). *Ectal excipulum* of textura globulosa, consisting of black cells, 8-10 µm diam, from which black hyphae are initiated (fig. 3-B). Two different kinds of hyphae are observed: wavy to spiral, black, septate tomentum hyphae partly covering the outside of the ascoma, 150-200 x 8-10 µm (fig. 3B) and usually straight and very long, black, septate subicular hyphae, of the same diameter, but up to 4000 µm long (fig. 3-C), covering the stipe and the substrate close to the ascoma.

Holotypus: Costa Rica, Area Corservación La Amistad Pacífico, Fila Chiquizá, on dead wood, gregarious, 21-XI-2000, *leg. M. Mata.* INB 0003300141.

DISCUSSION

Concerning the classification of the species of *Plectania* we believe that Paden's (1983) work, partially based on a previous one by Korf (1957), is perfectly valid at present time. The four established sections: A, *Plectania,* with ellipsoid spores; B, *Plicosporae*, with transverse forrows on the spores; C, *Curvatisporae,* with smooth, suballantoid spores and D, *Sphaerosporae,* with globose spores, fit very well the accomodation of all the known species of *Plectania.* Following this system is a recent contribution to Mexico (Medel & Chacón, 2000) where six species and two forms are recorded.

Fig. 1



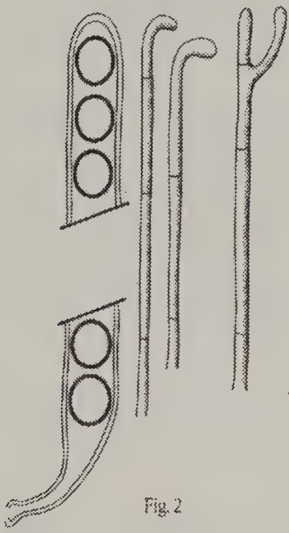


Fig. 2

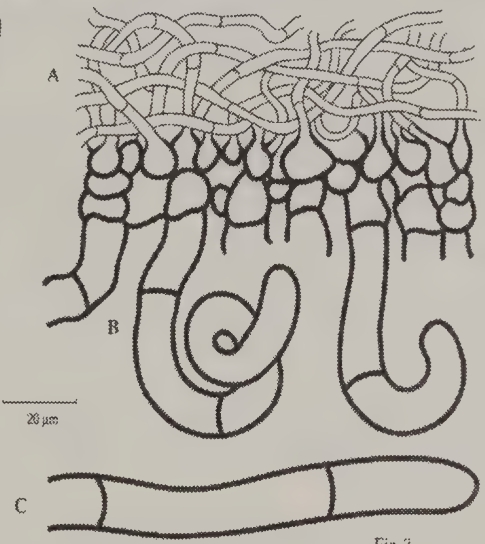


Fig. 3

Figs. 1-3.- *Plectania carranzae*. INB 0003300141. Holotypus.

Fig. 1.- Several ascomata growing isolated or gregarious forming a tomentum on the stipe and a black subiculum on a lignicolous substrate. Bar = 1 cm.

Fig.2 - Ascus with spores and paraphyses showing typical morphology. Bar = 20 µm.

Fig. 3.- A: medullary excipulum with textura intricate of thin-walled hyphae. B: external excipulum with textura globulosa made of black, thick-walled cells from which black hyphae initiate. C: a black straight subicular hyphae of the stipe and neighbouring area of the substrate. Bar = 20 µm.

In regard with *Plectania melaena* (Sow.: Fr.) Fuck., *P. nigrella* (Pers.: Fr.) Karst., *P. ericae* (Donadini). Korf, *P. mexicana* (Ellis & Holway) Paden and *P. campylospora* (Berk.) Nannf., they have bigger asci (200-275; 250-325; 250-280; 500-770 and 420-480 µm length respectively). Only *P. rhytidia* f. *platensis* (Speg.) Donadini, has similar length of asci (171-188 µm). The new species, *P. carranzae* can be distinguished from the rest of the taxa by the following characters: the size of asci and hairs, and the shape of the paraphyses. There is a resemblance between *P. melastoma* (Sow.) Fuck. and our proposed new species (Korf, pers. comm.). *Plectania melastoma,* the type of the genus *Plectania,* is very close to *P. carranzae.* It shows a certain macroscopic similarity, having a similar shape, size, color and subiculum, but they can be distinguished by the following characters: in *P. melastoma* spores are fusiform and bigger, 23-28 µm long, with asci 400-450 µm long (Paden, 1983).

None of the species described to date have tomentum or subicular hyphae like the ones present in *P. carranzae. Plectania nigrella* has been mentioned to have long hairs up to 380 µm long (Paden, 1983). Donadini (1987) gives a dimension of 150-250 x 2.8 - 4 µm. The other taxa shows shorter hairs, e. g. in *P. melaena* they reach 120 µm length. The size of tomentum and subicular hyphae in *P. carranzae*, up to 4000 µm long, and the two different sorts; straight and spiral, make this species unique. Only *P. campylospora* shows two types of hyphae: a sort of tomentum hyphae, twisted, septate; and other kind of subicular hyphae, erect, septate, both 4-8 µm thick, and normally encrusted, but the length is omitted (Paden, 1983).

Finally, the paraphyses curved in *P. carranzae* is another distinct character, since in the rest of species they are straight in *P. nigrella, P. melastoma, P. mexicana, P. rhytidia* and *P. campylospora,* spiral in *P. melaena*, or digitate in *P. ericae*, and *P. rhytidia* f. *platensis.*

In conclusion, we consider that the combination of characters shown by *Plectania carranzae*, is enough to propose it as a new species.

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A NATURAL MUTANT OF ASCOBOLUS MICHAUDII (ASCOMYCOTINA, PEZIZALES)

DIANA A. DOKMETZIAN and MARIA E. RANALLI

Departamento de Ciencias Biológicas, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires. Ciudad Universitaria, C 1428 EHA, Buenos Aires, Argentina. E-mail: dokmetzi@bg.fcen.uba.ar

ABSTRACT

Wild strains of *Ascobolus michaudii* produce 8-spored asci and uninucleate ascospores with thick longitudinal anastomosing lines in the exosporium. A natural mutant in heterozygous condition with ascospores showing a thin verrucosely ornated exosporium, was isolated. The exosporium types segregated in a ratio of 4:4 in the ascus, suggesting a typical Mendelian outcome controlled by a single allele pair. Six expected patterns were observed. Since mutant ascospores germinate normally, mutant homozygous cultures were obtained. Cultural studies using various media, shows no interference with the segregation pattern.

Key words: Ascobolaceae, *Ascobolus,* mutant, hybrid.

INTRODUCTION

Ascobolus michaudii Boud. is an ascomycete, a member of the order Pezizales (operculate ascomycetes), living in dung. It is a bipolar heterothallic fungus, with sexual compatibility controlled by a single pair of alleles *Aa*. The wild type produces apothecia with cleistohymenial development, which open in the early mesohymenial phase, exposing the mature asci which extend for over half their length beyond the paraphyses, giving the apothecial surface a blackish colour due to the dark mature ascospores. Ascospores are uninucleate, elongated and ellipsoid in shape. In the beginning they are hyaline and smooth, becoming ornamented and dark purple as they develop, to finally adopt a purple brown colour with a thick exosporium with longitudinal anastomosed crevices. Within the ascus, the ascospores are first arranged in two series in the upper third of the ascus then becoming irregularly biseriate until they finally become uniseriate when the ascus has lost turgor.

In our work, we have isolated from cow dung in a moist chamber, what we supposed was a natural heterozygote mutant of *A. michaudii* because when we first observed the asci under the microscope, we were able to detect in each one eight ascospores, four of which exactly matched the type of *A. michaudii* whilst the other four had an entirely different appearance. The difference was not only in shape, which was in fact within the normal range for *A. michaudii*, with slightly thinner poles, but also in the exosporium. This was incomplete, deposited as irregular and fragile warts, which were broken by slight pressure on the cover-slip leaving the ascospores without any exosporium.

The aim of this work was to isolate this natural mutant, study its growth in pure culture, observe the distribution pattern of the ascospores in the mature ascus of the heterozygote and show that such a stable characteristic as ascospore ornamentation, usually employed as a classification criterion, can be genetically altered without representing a barrier to reproduction and therefore avoid the fungus from being considered a different species.

MATERIALS AND METHODS

Mature apothecia were obtained from cow dung collected in Ciudad Universitaria (Buenos Aires) in April 1994. The apothecia developed in a moist chamber and produced asci which normally discharged their ascospores 10 days later. Ascospores were collected on water-agar medium following the methods used in previous work (Gamundí and Ranalli, 1966).

Normal ascospores were treated with 0.2% NaOH for 30 minutes at room temperature and incubated for 48 hours at 37°C. Mutant ascospores were left untreated. Once they germinated, monosporic cultures were obtained from the wild type and the mutant, which were then mated in a Petri dish with PF medium (Gamundí and Ranalli, op. cit.).

Monosporic strains 6, 15, 5 and 3 (BAFC 807, 808, 815 and 821) from the wild type and 3, 7, 4 and 8 (BAFC 1165, 1167, 1174 and 1199) from the mutant were used. All the strains belong to the Biological Sciences department of the Faculty of Exact and Natural Sciences of the University of Buenos Aires. They were kept in test tubes with PF medium at 5°C.

Culture media:

PF medium: filter paper, yeast extract (Ranalli and Forchiassin, 1976) in Petri dishes and in sloped test tubes.

GA medium: glucose–asparagine (Galvagno, 1976) in Petri dishes.

ET medium: Tindalised dung (one hour at 100°C three consecutive days).

RESULTS AND DISCUSSION

Ascobolus michaudii is a bipolar, heterothallic species which produces oidia for vegetative propagation and as an agent for spermatization. The mutation related to the exosporium does not affect the sexual compatibility.

Mutant ascospores germinate normally and carry the normal alleles for sexual compatibility. This allowed us to cross mutant strains in order to obtain the homozygous mutant strain.

Neither type of monosporic strains (wild type or mutant) produced fruiting bodies, so they were systematically crossed rendering two pairs of compatible strains for each type. So as to determine the polarity of each strain, each monosporic strain of a compatible pair was crossed with each one of the monosporic strains of another compatible pair. From the compatibility assays we concluded that the wild type strains 6 and 15 carry the *A* allele and the 5 and 3 carry the *a* allele, whilst those of the mutant strains 3 and 7 carry the *A* allele but the 4 and 8 carry the *a* allele.

When we crossed the wild type strains with the mutant strains we obtained the expected proportion of hetrozygous asci. Apparently, these ascospores appear in the presence of a mutant allele for the deposition of the exosporium, which segregates in the ascus in a 4:4 ratio with respect to the normal one, which in general terms responds to a classic Mendelian character controlled by a single pair of alleles.

It seems clear that this factor controlling the deposition of exosporium, does so in the last stages of the ascospore development and therefore does not affect their sexual compatibility nor their viability. It has a direct phenotypic effect which enables an immediate recognition of the ascospores within the ascus without any complication of recessive or dominant effects as they are haploid and uninucleated.

The cross 6 x 5 produced normal eight-spored asci (fig. 1, D), the 7 x 8 cross asci containing mutant ascospores (fig.1, E) and the 6 x 8 and 5 x 7 crosses produced a large number of fruiting bodies with asci containing four mutant and four normal ascospores arranged in the six patterns expected for a pair of alleles which segregate normally (fig. 1, F-I).

PF and ET were the media in which more fruiting bodies were obtained. Light was a decisive factor for fruiting body development. Fruiting bodies were not produced in complete darkness as in the case of *Ascobolus amoenus* (Dokmetzian et al., 1995) in which even though they are formed in complete darkness, they take a longer time to develop and although ascospores matured they are not forcibly expelled from the asci.

In the incubator at 23°C and continuous light the complete life cycle was accomplished in 10 days. No significant differences were obtained in the different matings under the culture conditions they were subject to. When the cultures grown for 10 days in darkness were given continuous light apothecium primordia were formed which never matured, perhaps because of the aged mycelium (Forchiassin and Diorio, 1991).

The fruiting bodies which produced normal ascospores in ET medium were cup shaped, substipitate, with a thick festooned edge and abundant furfurations which may become reddish coloured (fig.1, A). In PF medium, the fruiting bodies which produced normal ascospores only appeared in the mid line while those producing mutant spores appeared dispersed throughout all the Petri dish, disguising the mid line. In GA medium the fruiting bodies are grouped and produce a lower number of asci than in PF medium.

The ascospores produced by the wild type homozygote resulting from the 6 x 5 mating present a thick exosporium with longitudinal anastomosed grooves (fig. 1, B) which are the normal characteristic described for the species whilst the ascospores of the mutant homozygote resulting from the 7 x 8 mating have an incomplete exosporium, deposited as irregularly distributed warts (fig. 1, C), which are initially purple and, as the ascospores develop, become dark brown. The heterozygous strains (6 x 8 and 5 x 7) present four wild type ascospores and four mutant (rough) ones; each type with the characteristics described above for the respective homozygote.

The assays to induce germination, all worked on the permeability of the exosporium allowing water imbibition of the ascospore, which showed no further dormancy. The difference in the exosporium was noted by the fact that mutant ascospores needed no special treatment for germination, but the wild type ascospores only had 100% germination after a treatment for 30 minutes with 0.2% NaOH.

The presence of the two types of ascospores in the asci of the heterozygous fruiting body found on the original dung immediately attracted our attention. There is extensive bibliography on mutants for ascospore colour in Ascomycetes, among which we can outline Bistis & Olive, 1954; Bistis, 1956; Olive, 1956, 1959; Kitani et al., 1962; Stadler & Towe, 1971 and Paquete, 1978. In our case, not only was the colour involved, but the external appearance and spore measurements, which might have led to considering it a new species had we first found the mutant homozygous type instead of the heterozygous one.

The second surprising point was that the asci segregation was always 4:4. This was repeatedly confirmed and was found in all the heterozygous strains studied.

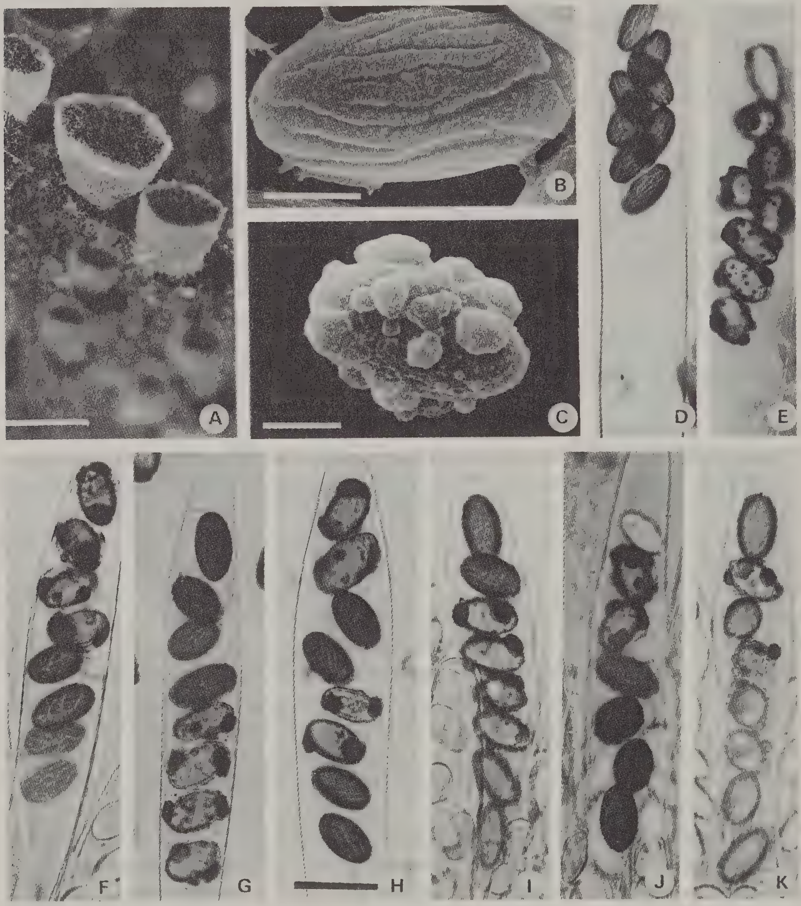

Figure 1: A fruiting bodies of *Asobolus michaudii* produced in Tindalised dung (bar: 1700 µm); B: wild type ascospore (bar: 5 µm); C: mutant ascospore (bar: 5µm); D: ascus with eight normal ascospores in two series; E: ascus with eight mutant ascospores; F, G, H, I: heterozygous asci showing different ascospore arrangements; J: heterozygous ascus with aborted ascospores; K: heterozygous ascus with an unexpected spore arrangement (D–K bar: 25 µm).

The ascospores were arranged in the six patterns which are expected to arise from a character controlled by a single pair of alleles which can segregate in the first or second meiotic division depending on the possibility or not of crossing over. The same happens in *Neurospora crassa* and *N. sitophila* where the arrangement with respect to any pair of alleles is an exact replica of the meiotic segregation in the ascus where there is no overlapping of spindles nor nuclear or ascospore migrations (Ryan, 1943; Lindergren, 1953).

Only very rarely did we observe 4:4 arrangements different from the expected, (fig. 1, K) probably due to failures in the cytoskeleton during the arrangement of the nuclei in the ascus, guided by actin microfilaments (Thompson-Coffe & Zickler, 1993).

Also as rarely we found hyaline ascospores (fig. 1, J) which were able to germinate but produce a sterile mycelium which, when systematically crossed between themselves never produced fruiting bodies. The production of these "abortive" ascospores might be the consequence of incorrect rearrangement and distribution of the chromosomes during meiosis in the ascus.

The ascus is a specialised hypha, showing determinate growth (Read, 1994) within which ascospores are formed by a process traditionally called "free cell formation" (Harper, 1987) which involves compartmentalization of the cytoplasm of the ascus by a special mechanism of double membranes, synthesis and deposition of cell wall material in between the membranes (Beckett, 1981). Mims et al. (1990) have thoroughly studied this membrane system in *Ascodesmis nigricans*. Czymmek and Klomparens (1992) have demonstrated the structural continuity with the cell membrane of the ascus in *Thelebolus crustaceus*. A controlled synthesis of membranes and its subsequent joining is needed during the delimitation of ascospores at a morphological level. The components of the cell wall must therefore be synthesised and also joined between the two membranes (Beckett, op. cit.), but the factors controlling these processes are only partially understood nowadays (Read & Beckett, 1996).

According to Beckett (1981) two basic types of cell wall material can be recognised: 1) primary wall, which is the one initially deposited between the two membranes and 2) secondary wall, which is formed subsequently over the primary wall as a modification of the latter or an addition to it. The formation of the secondary wall may involve chemical changes and may vary considerably in structure, composition and differentiation pattern. It is typically pigmented and ornamented. After nuclear delimitation, it is logic to assume that the nuclear genes inside the spore play the principal role in the control and deposition of the wall and its architecture; nevertheless, there is evidence which suggests that while the epiplasm is present, it plays an important part in the deposition of the wall and its pigmentation (Becket, 1981; Carroll, 1969; Delay, 1966; Illingworth et al., 1973; Lynn & Magee, 1970; Mainwaring, 1972; Merkus, 1973, 1974, 1975). When the epiplasm disappears, we can consider that the control of the secondary wall deposition is assumed by the nuclear activity of the ascospore, its protoplast and its membrane (Read & Beckett, 1996). In some Ascomycetes, endoplasmic reticulum cisternae located at the periphery of the protoplast, may also mediate the deposition of secondary cell wall (Reeves, 1967; Lynn & Magee, 1970; Beckett, 1981). However Merkus (1973, 1974) claimed that the formation of the secondary wall in *Ascodesmis microscopica* and *Ascodesmis nigricans* was due to the activity of the epiplasm. There is evidence in *Thelebolus crustaceus* that the ascus epiplasm remains both viable and active during the ascospores´ secondary wall ontogeny until they have matured (Czymmek & Klomparens, 1992). The same was found for *Ascobolus immersus* (Wu & Kimbrough, 1992) and certain genera of Ciliarieae (Wu & Kimbrough, 1991). However, Carroll, (1969) showed that hybrid asci in *Ascodesmis sphaerospora* formed as a result of crossing the normal type with reticulate spores and a mutant with bumpy spores contained four reticulate and four bumpy ascospores, suggesting that, in this species, the ascus epiplasm plays no part in secondary wall ornamentation. A similar thing happens with the ascospores of *Ascobolus michaudii*, given that the hybrid asci contain both types of ascospore. In this case we suggest that the difference in the exosporium might be a consequence of an enzymatic deficiency in the synthetic process and deposition of the pigment of the exosporium (secondary wall) and that it is related to the presence of the mutant allele.

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MYCOTAXON

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A NEW SPECIES AND FURTHER NEW RECORDS IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) FROM THE PHILIPPINES

JOHN A. ELIX

Department of Chemistry, The Faculties, Australian National University,
Canberra, ACT 0200, Australia
email: John.Elix@anu.edu.au

PAULINA A. BAWINGAN & YOLANDA G. FLORES
Natural Sciences Research Unit, Saint Louis University, Baguio City 2600,
Philippines
email: cnsru@slu.edu.ph

ABSTRACT : *Rimelia pustulata* from Australia and the Philippines is described as new to science. In addition, 6 species of Parmeliaceae are reported for the first time for the Philippines. The new combination *Parmotrema adspersum* is made.

KEY WORDS: *Parmotrema adspersum, Rimelia pustulata, Canoparmelia, Hypotrachyna, Myelochroa, Parmelinopsis, Parmotrema*

In recent years there has been a significant increase in interest and appreciation of the lichen flora of Philippines, with localised studies of lichen biodiversity (Bawingan *et al.* 2000.), as well as several intensive field investigations by F. Schumm (Elix & Schumm 2001). We have now undertaken a detailed survey of the recent collections of Parmeliaceae from Benguet and Mountain Provinces in the Philippine island of Luzon culminating in our describing a species new to science and 6 new records for the country. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Feige *et al.* 1993; Elix & Wardlaw 2000) and comparison with authentic samples.

Rimelia pustulata Elix & Bawingan, sp. nov. Fig. 1

Thallus ut in *Rimelia austrocetrata* sed superfice superiore pustulata et sorediata differt.
Type: AUSTRALIA. Western Australia: Mt Clarence, Albany, 35°02'S, 117°54'E, 230 m, on shaded granite ledges in dry sclerophyll forest with large granite outcrops, *J. A. Elix 41377, H. T. Lumbsch & H. Streimann*, 15 Sept. 1994; holo: CANB; iso: HO, PERTH here designated.

Thallus saxicolous or corticolous, foliose, loosely adnate, coriaceous, to 15 cm wide. *Lobes* imbricate, subirregular, 5-15 mm wide; margins entire, sinuous; apices rotund, ±laciniate; laciniae flat to subconvex, 0.5-1.5 mm wide; cilia sparse, simple, 0.2-0.8 mm long. *Upper surface* pale grey to grey-green, flat, becoming rugose, white-reticulate, conspicuously reticulately cracked at the lobe margins, becoming areolate; areolae flaking off submarginally and exposing the medulla which becomes ±blackened; isidia absent, pustulate-soredia present; pustules developing submarginally and ultimately spreading to the centre of the thallus; soredia developing from pustules, coarse, granular, often coralloid, becoming blackened, ±becoming partially corticate and forming pseudoisidia. *Medulla* white. *Lower surface* black, with a brown marginal zone; rhizines moderate to sparse, unevenly distributed, ±grouped submarginally, simple or sparingly squarrosely branched, slender; marginal zone papillate or erhizinate. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K+ yellow; medulla K+ yellow then dark red, C-, KC+ red, P+ orange; containing atranorin (minor), chloroatranorin (minor), salazinic acid (major), consalazinic acid (minor).

Rimelia pustulata closely resembles *R. austrocetrata* (Elix & J. Johnst.) Hale & A. Fletcher, as these two species have similar loosely adnate thalli with sparse cilia, a deeply cracked and areolate upper surface where the areolae ultimately flake off, and contain salazinic and consalazinic acids in the medulla (Elix & Johnston 1988). However, *R. austrocetrata* is esorediate, lacking the characteristic sorediate pustules observed in *R. pustulata*. *Rimelia pustulata* could possibly be confused with the very common *R. reticulata* (Taylor) Hale & A. Fletcher, since both are sorediate and have identical chemistry. However, *R. reticulata* lacks the flaking areolae, and the formation of extensive pustules and partially corticate, coralloid, pseudoisidia (Hale & Fletcher 1990). At present, the new species is known from several localities in southern Australia and from Mountain Province, Luzon, in the Philippines.

Further Specimens Examined
AUSTRALIA. Western Australia: West Cape Howe, 35°08'S, 117°36'E, on granite rocks, *M. F. Day 85/71, 85/74*, 19 Sept. 1985 (CANB). South Australia: Kangaroo Island, Dudley Peninsula, Chapman River Estuary, Antechamber Bay, 35°50'S, 138°05'E, 3 m, on rocks in coastal scrub, *J. A. Elix 19697 & L. H. Elix*, 28 Oct. 1985 (CANB).

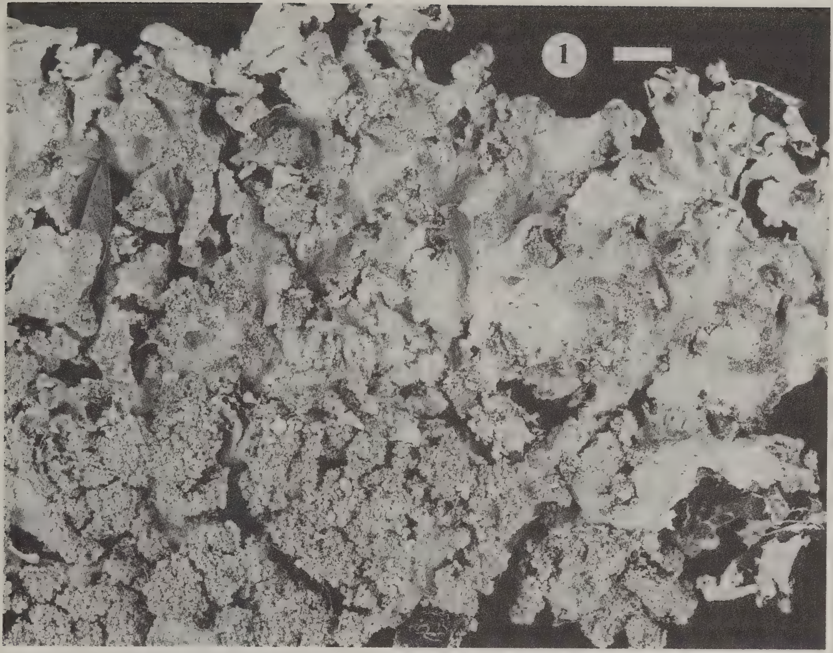

Figure 1. *Rimelia pustulata* (holotype in CANB). Scale bar = 5 mm.

PHILIPPINES. Luzon, Mountain Province: Mt Data National Park, 16°52'N, 120°52'E, 2305 m, on mossy branch in rainforest, *P. Bawingan & Y. Flores CL 0125,* 17 Apr. 2000 (CANB); Bana-ao, Tadian, 16°55'N, 120°49'E, 1516 m, on branch in rainforest, *P. Bawingan CL 0073,* 9 Apr. 2000 (CANB).

New Records of Parmeliaceae for the Philippines

Canoparmelia aptata (Kremp.) Elix & Hale, *Mycotaxon* **27**: 278 (1986).

A widely distributed paleotropical species also known from Africa, India, Indonesia, Japan and Australia (Elix 1994a; Hale 1976a).

Specimen Examined
PHILIPPINES. Luzon, Mountain Province: Bontoc, 17°05'N, 120°59'E, 1196 m, on bark in *Pinus* forest, *Tammy Collalad CL0195,* 15 July 2000 (CANB).

Hypotrachyna immaculata (Kurok.) Hale, *Smithsonian Contr. Bot.* **25**: 41 (1975).

A temperate and tropical species also known from Australia, Africa, Thailand, Taiwan and South America (Elix 1994b; Hale 1975; Kurokawa & Lai 2001; Pooprang *et al.* 1999).

Specimen Examined
PHILIPPINES. Luzon, Benguet Province: Mt Santo Tomas, Tuba, 16°20'N, 120°33'E, *ca.* 2450 m m, on *Pinus* in evergreen forest, *P. Bawingan, Y. Flores & P. Rosuman CL0013,* 21 Nov. 1999 (CANB).

Myelochroa denegans (Nyl.) Elix & Hale, *Mycotaxon* **29**: 240 (1987).

A scattered southern Asian species known from India, Sri Lanka, Malaysia (Sabah), Taiwan and Australia (Elix 1994c; Hale 1976b; Kurokawa & Lai 2001).

Specimen Examined
PHILIPPINES. Luzon, Benguet Province: Botanical Gardens, Baguio City, 16°24'N, 120°35'E, *ca.* 1200 m, on tree branch, *P. Bawingan CL0017*, 15 Oct. 1999 (CANB).

Parmelinopsis expallida (Kurok.) Elix & Hale, *Mycotaxon* **29**: 242 (1987).

A relatively rare tropical Asian species also known from India, Thailand and Taiwan (Hale 1976b; Kurokawa & Lai 2001).

Specimen Examined
PHILIPPINES. Luzon, Benguet Province: Botanical Gardens, Baguio City, 16°24'N, 120°35'E, *ca.* 1200 m, on tree branch, *P. Bawingan CL0009,* 15 Oct. 1999 (CANB).

Parmotrema ultralucens (Krog) Hale, *Mycotaxon* **1**: 108 (1974).

This species was previously known from East Africa, North and Central America (Krog 1974), Japan, Papua New Guinea and Pacific Islands (Elix & McCarthy 1998; Louwhoff & Elix 1999), Sri Lanka, Taiwan (Kurokawa & Lai 2001) and Australia (Elix 1994d).

Specimen Examined
PHILIPPINES. Luzon, Mountain Province: Bontoc, 17°05'N, 120°59'E, 1196 m, on bark in *Pinus* forest, *P. Bawingan, P. Rosuman & E. Singson CL 0131,* 5 May 2001 (CANB).

Parmotrema vartakii Hale, *Mycotaxon* **5**: 441 (1977)

This species was previously known only from India (Hale 1977).

Specimen Examined
PHILIPPINES. Luzon, Mountain Province: Madongo, Sagada, 17°15'N, 120°54'E, 1690 m, on bark in *Pinus* forest, *P. Bawingan, P. Rosuman & E. Singson CL 0139,* 6 May 2001 (CANB).

New Combination

Parmotrema adspersum (Vain.) Elix, comb. nov.

Basionym: *Parmelia adspersa* Vain., *Hedwigia* **46**: 168 (1907).

This species is common in the Philippines and Thailand and is related to *Parmotrema saccatilobum* (Taylor) Hale. It was formerly included in *Canoparmelia* but the ascospores are thick-walled, 16-18 x 6-8 µm, and typical of *Parmotrema.*

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THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) ON GOUGH ISLAND, SOUTH ATLANTIC OCEAN

JOHN A. ELIX

Department of Chemistry, The Faculties, Australian National University,
Canberra, ACT 0200, Australia
email: John.Elix@anu.edu.au

NIEK J. M. GREMMEN

Data Analyse Ecologie, Dwarsdrift 24, 7981 AP Diever, The Netherlands
email: gremmen@wxs.nl

ABSTRACT : Nine parmelioid taxa in five genera were identified from Gough Island, South Atlantic Ocean. These comprise three species of *Hypotrachyna*, one species of *Parmelinopsis*, three species of *Parmotrema*, one species of *Punctelia* and one species of *Rimelia*. Although the majority of species have a pantemperate or cosmopolitan distribution, a significant South American element is also evident. Eight of the species collected on Gough Island produce isidia or soredia, confirming that such vegetative propagules aid in long distance dispersal by means of wind and/or birds.

KEY WORDS: *Hypotrachyna, Parmelinopsis, Parmotrema, Punctelia, Rimelia*

INTRODUCTION

Gough Island (40°21'S, 9°53'W) is an uninhabited, cool-temperate oceanic island, situated in the South Atlantic Ocean, about midway between the southern tip of Africa and South America. It is part of the Tristan-Gough group of islands, and is *ca.* 300 km removed from the other islands of this group.

The island measures *ca.* 6 by 14 km, and is mountainous. The highest peak reaches 910 m above sea level, and much of the island is above 400 m. On most sides the uplands fall away very steeply to the coast, but the high coastal escarpments are dissected by numerous steep and narrow valleys. The island is of volcanic origin, but shows no signs of recent volcanic activity. The climate is cool and wet, with a mean temperature at sea level of *ca.* 11°C, mean annual precipitation in excess of 3000 mm, and frequent gale-force winds.

The lowlands of Gough are covered in a lush vegetation, dominated by the island tree (*Phylica arborea*), tree ferns (*Blechnum palmiforme*), numerous other ferns and grasses, sedges and rushes. Coastal areas are covered in over 2 m high, dense tussock grassland. More elevated areas are covered by thick heath and grassy vegetation, rich in bryophytes. In flat upland areas mires and bogs developed, dominated partly by *Sphagnum*, partly by other mosses and hepatics. Upland ridges and hilltops are covered by an open, bryophyte-rich montane vegetation on thin soils. A detailed description of the vegetation is given by Wace (1961).

Some lichen collections have been made in the past (Christophersen 1934, Wace & Dickson 1965), but knowledge of the non-vascular flora of the island appears to be very incomplete. In September 1999 a collection of lichens was made on Gough Island by N. J. M. Gremmen. The present paper identifies the species of Parmeliaceae in this collection, and provides a key to the species of this family on Gough Island.

MATERIALS AND METHODS

Collections of Parmeliaceae from a variety of habitats on Gough Island were examined using morphological and chemical characteristics and are deposited in Bergen (BG). Chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson *et al.* 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993) and high performance liquid chromatography (Elix & Wardlaw 2000; Feige *et al.* 1993).

RESULTS

Nine species in five genera were recognized among Gough Island collections of Parmeliaceae. The parmelioid genera best represented on the island are *Hypotrachyna* and *Parmotrema* (each with 3 species). *Hypotrachyna endochlora*, *Parmotrema crinitum* and *Rimelia reticulata* are common lichens in many regions of the world and also widespread across the South Atlantic. *Punctelia canaliculata* was encountered for the first time outside South America.

Key to the Parmeliaceae on Gough Island

1 Lower surface erhizinate at lobe margins...2
Lower surface rhizinate to lobe margins 4

2(1) Thallus sorediate; medulla K-; stictic acid absent 3
Thallus isidiate; medulla K+ yellow; stictic acid present........................
.... *Parmotrema crinitum*

3(2) Lobe margins ciliate; medulla UV+ blue-white; alectoronic acid
present...*Parmotrema arnoldii*
Lobe margins eciliate; medulla UV-; protocetraric acid present
.... *Parmotrema gardneri*

4(3) Lower surface pale yellow to pale brown; soredia and isidia absent......
....*Punctelia canaliculata*
Lower surface black; soredia or isidia present... 5

5(4) Isidia and/or lobules present; soredia absent.. 6
Isidia and lobules absent; soredia present...7

6(1) Upper cortex yellow-green; usnic acid present; lobules absent..............
....*Hypotrachyna microsticta*
Upper cortex grey; atranorin present; lobules present............................
....*Hypotrachyna bogotensis*

7(5) Upper cortex effigurately maculate to reticulately cracked; medulla
K+ yellow then red; salazinic acid present.................*Rimelia reticulata*
Upper cortex emaculate or faintly maculate; medulla K-; salazinic
acid absent... 8

8(7) Lobe margins ciliate; medulla white; secalonic acid A absent ....
.... *Parmelinopsis afrorevoluta*
Lobe margins eciliate; medulla yellow; secalonic acid A present
.... *Hypotrachyna endochlora*

The Species

1. Hypotrachyna bogotensis (Vain.) Hale, *Smithsonian Contr. Bot.* 25: 23 (1975)

This species has primarily a Neotropical distribution but is also present in Hawaii and southern South America (Chile) and Juan Fernandez (Hale 1975). It is characterized by the presence of atranorin, evernic acid and lecanoric acid, the white-maculate upper surface and the cylindrical isidia (which become procumbent and dorsiventral) and ±dense lobules. On Gough Island this species is corticolous on *Phylica* branches at moderate elevations (100-110 m).

Specimens examined: Gough Island: inland from Transvaal Bay, 110 m, on bark of thick *Phylica* tree in open *Phylica* bush, *N. Gremmen 99-371B, 99-371C*, 21 Sept. 1999; inland from The Admiral, 100 m, on stems of *Phylica* tree in dense *Phylica* bush, *N. Gremmen 99-376*, 21 Sept. 1999.

2. Hypotrachyna endochlora (Leight.) Hale, *Smithsonian Contr. Bot.* 25: 34 (1975)

This cosmopolitan species is widespread in the Southern Hemisphere, including South America, South Africa, St. Helena, Madagascar (Hale 1975), Tristan da Cunha (Jørgensen 1977) and Papua New Guinea (Kurokawa 1979; Streimann 1986). It is characterized by the sublinear, mineral-grey to yellowish-grey lobes, the subterminal soralia which are ±pustulate, the lemon-yellow to lime-green medulla and by the presence of obtusatic acid (major), barbatic acid (minor), evernic acid (minor), norobtusatic acid (minor) and secalonic acid A (minor) in the medulla.

Specimen examined: Gough Island: inland from Transvaal Bay, 110 m, on bark of thick *Phylica* tree in open *Phylica* bush, *N. Gremmen 99-371A*, 21 Sept. 1999.

3. Hypotrachyna microblasta (Vain.) Hale, *Smithsonian Contr. Bot.* 25: 47 (1975)

Normally a species of tropical montane regions (900-3100 m elevation) in South and Central America, Southeast Asia, Hawaii (Hale 1975), Tristan da Cunha (Jørgensen 1977) and Papua New Guinea (Kashiwadani 1975; Kurokawa 1979), *H. microblasta* is characterized by the yellow-green, subdichotomously to dichotomously branched lobes with truncate apices, the cylindrical isidia which are rarely sparingly lobulate or ciliate, the presence of cortical usnic acid and medullary galbinic acid (major), norstictic acid (minor) and salazinic acid (minor).

Specimen examined: Gough Island: SE slope of Tafelkoppie, 350 m, on mat of small ferns (*Hymenophyllum*) and bryophytes on a stem of a tree fern (*Blechnum palmiforme*), *N. Gremmen 99-725*, 23 Sept. 1999.

4. Parmelinopsis afrorevoluta (Krog & Swinsc.) Elix & Hale, *Mycotaxon* 29: 242 (1987)

This species has a pantropical to pantemperate distribution (but is absent from Europe) (Elix 1994; Krog & Swinscow 1979). It is characterized by the ascending, ±revolute lobes with dentate margins and simple cilia, the laminal and submarginal pustular soralia (with granular soredia), and by the presence of atranorin, chloroatranorin, gyrophoric acid (major), 5-*O*-methylhiascic acid (minor), 4,5-di-*O*-methylhiascic acid (minor), umbilicaric acid (trace) 2,4,5-tri-*O*-methylhiascic acid (trace) and lecanoric acid (trace). *Hypotrachyna revoluta* (Flörke) Hale resembles *P. afrorevoluta* morphologically and chemically, but the former can be distinguished by the more coriaceuos thallus, rhizines which are consistently dichotomously branched rather than being simple or bifurcate, and by the absence of cilia.

Specimen examined: Gough Island: near Weather Station, 40 m, epiphyte on branches of *Phylica arborea*, *N. Gremmen 99-305B*, 12 Sept. 1999.

5. **Parmotrema arnoldii (Du Rietz) Hale**, *Phytologia* 28: 335 (1974)

Although *P. arnoldii* is common in the Northern Hemisphere, including Europe, North and Central America and the Caribbean (Hale 1965), it is much more scattered in the Southen Hemisphere having been recorded from Chile (Hale 1965) and New Zealand (Malcolm & Galloway 1997). It is a characterized by the loosely adnate thallus, the ciliate lobe margins, dentate marginal laciniae which become sorediate, the soralia expanding into ±extensive abraded patches, the tips of the sorediate lobes becoming revolute, and the presence of alectoronic and a-collatolic acids (UV+ blue-white) in the medulla. On Gough Island this species is corticolous on living and dead *Phylica* trees at low elevation.

Specimen examined: Gough Island: Tafelkoppie, 500 m, on bryophytes on a rock outcrop in a boggy area, *N. Gremmen 99-712*, 23 Sept. 1999.

6. **Parmotrema crinitum (Ach.) M. Choisy**, *Bull. Mens. Soc. Linn. Soc. Bot. Lyon* 21: 175 (1952)

A cosmopolitan species, widespread in humid habitats in temperate and tropical regions (Elix 1994; Hale 1965), including Australia, South Africa, South America, New Zealand (Malcolm & Galloway 1997) and Tristan da Cunha (Jørgensen 1977) in the Southern Hemisphere. It is a morphologically variable species characterized by the adnate thallus, the ciliate lobe margins, copious isidia which are often apically ciliate, and the presence of the stictic acid chemosyndrome in the medulla. On Gough Island this species is corticolous on living and dead *Phylica* trees at low elevation.

Selected specimens examined: Gough Island: near Weather Station, 40 m, epiphyte on branches of *Phylica arborea*, *N. Gremmen 99-305C*, 12 Sept. 1999; Transvaal Bay, 35 m, on bark of dead *Phylica* tree near the coast, *N. Gremmen 99-396A*, 22 Sept. 1999.

7. **Parmotrema gardneri (C.W. Dodge) Sérus.**, *Bryologist* 87: 5 (1984)

This is a pantropical species known from Africa, Australia, Papua New Guinea and South America (Elix 1994; Sérusiaux 1984). Most probably collections of *Parmotrema cf. dilatatum* (Vain.) Hale from Tristan da Cunha (Jørgensen 1977) also refer to this species. It is characterized by a loosely to moderately adnate, coriaceous thallus with eciliate or very sparingly ciliate lobes, marginal soralia with granular soredia, and the presence of atranorin, chloroatranorin, protocetraric acid (major) with or without unidentified fatty acids (major/minor). On Gough Island this species is corticolous at moderate elevations.

Specimens examined: Gough Island: inland from The Admiral, 130 m, on bark of *Phylica* tree in dense *Phylica* bush on ridge, *N. Gremmen 99-366*, 21 Sept. 1999; inland from Transvaal Bay, 150 m, on moss cushion on stem of tree fern, *N. Gremmen 99-723*, 23 Sept. 1999.

8. Punctela canaliculata (Lynge) Krog, *Nordic J. Bot.* 2: 291 (1982)

This South American species (Krog 1982; Ferraro 1986) is characterized by the pale lower surface, the narrow, canaliculate lobes with conspicuous, orbicular pseudocyphellae on the upper surface, the lack of soredia and isidia, the filiform conidia and the presence of medullary fatty acids (major/minor). Although normally corticolous, on Gough Island this species was found on coastal rocks.

Specimen examined: Gough Island: Seal Beach, 10 m, on large rock near penguin colony, *N. Gremmen 99-711*, 22 Sept. 1999.

9. Rimelia reticulata (Taylor) Hale & A. Fletcher, *Bryologist* 93: 28 (1990)

This very common species is widely distributed throughout the world (Hale & Fletcher 1990) including Tristan da Cunha (Jørgensen 1977). *Rimelia reticulata* is characterized by the effigurately maculate to reticulately-cracked upper cortex, ciliate lobe margins, laciniae with marginal to submarginal soredia, and by the presence of atranorin, chloroatranorin, salazinic acid (major) and consalazinic acid (minor). It is morphologically very variable, and the most common parmelioid species on Gough Island. It occurs on trees, rocks and dead wood and in the dense *Phylica* thickets, *R. reticulata* is the dominant epiphyte forming large clumps.

Representative specimens examined: Gough Island: Weather Station, 40 m, on wooden planks of stairs at entrance to base building, *N. Gremmen 99-353*, 19 Sept. 1999; inland from The Admiral, 120 m, on thick *Phylica arborea* branches in dense *Phylica* bush, *N. Gremmen 99-387*, 21 Sept. 1999; Transvaal Bay, 10 m, on coastal rocks, *N. Gremmen 99-371A*, 21 Sept. 1999.

Biogeographical Considerations

Species with vegetative propagules are often successful long-distance colonizers (Galloway 1979) as the isidia, soredia or thallus fragments are easily transported by wind. Vegetative propagules may also be dispersed by migratory birds (Galloway 1979; Jørgensen 1983) which nest in places such as Gough Island. Although these methods of dispersal also apply to spores, this only ensures transportation of one component of the lichen thallus, so propagules or thallus fragments (with both fungal and algal components) are a more efficient means of dispersal. Thus, the isidiate or sorediate counterparts of fertile species are usually much more widespread (Jørgensen 1983) so it is not surprising that eight of the nine species found on Gough Island bear vegetative propagules.

Overall, two major floristic elements can be distinguished: the widespread cosmopolitan or pantemperate species and those confined to the Southern Hemisphere, in particular, the South American species. The latter includes *Punctelia canaliculata* (previously known from Argentina and Uruguay) and *Hypotrachna bogotensis* (with a wider distribution along the entire length of the Andes). *Hypotrachyna microblasta* not only occurs along the length of the Andes, but also in Madagascar, Réunion, Papua New Guinea and Hawaii. The parmeliod flora of Gough Island not only resembles that of southern South America, but also that of the nearest land, the islands of the Tristan da Cunha group (Jørgensen 1977, 1979). This distribution pattern and the fact that the large majority of species bear isidia or soredia provide compelling evidence that the predominant westerly winds (the "roaring forties") have acted as an efficient dispersal agent of lichen propagules.

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See Errata

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LICHENICOLOUS FUNGI ON IONASPIS LACUSTRIS

ALAN ORANGE

Department of Biodiversity and Systematic Biology,
National Museum and Gallery, Cardiff CF10 3NP, U.K.
e-mail: alan.orange@nmgw.ac.uk

ABSTRACT: Eight lichenicolous fungi are reported from *Ionaspis lacustris* in Europe. Three species are described and illustrated in detail: *Sagediopsis lomnitzensis* (also from *Ionaspis odora*) and *Zwackhiomyces lacustris* are new combinations, *Verrucaria conturmatula* is accepted as the first non-lichenized, lichenicolous member of this genus. A neotype is designated for *S. lomnitzensis*. A key is provided to species on *I. lacustris*.

KEYWORDS: Verrucariales, Dothideales, Europe, freshwater lichens.

Introduction

Ionaspis lacustris (With.) Lutzoni (*Hymenelia lacustris* (With.) M. Choisy) grows on siliceous rocks in streams and on lake margins. In the British Isles it is abundant in the north and west, and is tolerant of acidic waters. The generic position was revised by Lutzoni & Brodo (1995). This species is frequently infected by lichenicolous fungi, and colonies are often infected by more than one species. Only one lichenicolous species was reported for this host by Hawksworth (1983), and another by Clauzade *et al.* (1989). *Kalaalia reactiva* (Alstrup & Hawksworth 1990) and *Endococcus verrucosporus* (Alstrup *et al.* 1994) have recently been described from *I. lacustris*. Fungi reported from this host in Europe are reviewed below.

Methods

Sections were prepared by hand. The following reagents were used at least once: Congo Red: 1% solution in water, mixed 1: 1 with 10% KOH; I (Lugol's Iodine: I 0.5 g, KI 1.5 g, water 100 ml); Chorazol Black: material heated to near boiling point on open slide in solution of stain in c. 2.5% KOH, then a c. 2.5% solution of concentrated hydrochloric acid added, following the method of Nash *et al.* (1990); K: 10% KOH; Cotton Blue in lactophenol (BDH). Ascospore measurements made in water or K; size ranges quoted with mean value in bold type.

See Errata

The species

Endococcus rugulosus Nyl. (Verrucariaceae)
Recorded on *Ionaspis lacustris* from the Faroes (Alstrup *et al.* 1994). No material of this taxon was seen on this host during the present study.

Endococcus verrucosporus Alstrup (Verrucariaceae)
This species was described from *Ionaspis lacustris* in the Faroes (Alstrup *et al.* 1994), and is also known from Ireland, Scotland (Coppins 2000), Wales and England. It differs from *E. rugulosus* in the verrucose ascospores. Ascospores measured in British material were (9-)9.5–**11.4**–13.5(-14.5) × 5.5–**6.5**–7.5(–8) µm, 1.4–**1.8**–2.2(–2.4) times as long as wide (96 measured).

Selected specimens examined: **Great Britain:** *Wales*: Breconshire (V.C. 42), Fforest Fawr, 5.5 km north of Ystradfellte, near Maen Llia, Afon Llia, 22/925189, alt. 415 m, 30 June 1990, *A. Orange* 8036 (NMW C.1999.010.2). Merioneth (V.C. 48), Ganllwyd, east side of Afon Mawddach, downstream of Ty'n-y-Groes Hotel, 23/728230, 12 August 1999, *A. Orange* 12618b (NMW C.2001.027.21). *England*: Cumberland (V.C. 70), Borrowdale, 30 August 1933, *D.A. Jones* (NMW 37.135.518, sub *Ionaspis lacustris*). – **Ireland:** East Donegal (V.C. H34), 1.5 km WSW of Barnesmore village, River Lowerymore, 24 August 1998, *A. Orange* 12502 (NMW C.1998.016.33, sub *Kalaalia reactiva*).

Kalaalia reactiva Alstrup & D. Hawksw. (Dacampiaceae)
Described by Alstrup and Hawksworth (1990) from *Ionaspis lacustris* in Greenland; also known from Ireland and north and west Britain.

Selected specimens examined: **Great Britain:** *Wales*: Merioneth (V.C. 48), Ganllwyd, east side of Afon Mawddach, downstream of Ty'n-y-Groes Hotel, 23/728230, 12 August 1999, *A. Orange* 12618a (NMW C.2001.027.20); Caernarvonshire (V.C. 49), Pass of Llanberis, Afon Las, 23/624581, alt. 550 m, 23 June 1998, *A. Orange* 12357 (NMW C.2001.027.15). *England*: Cumberland (V.C. 70), Borrowdale, 30 August 1933, *D.A. Jones* (NMW 37.135.518, sub *Ionaspis lacustris*). – **Ireland:** East Donegal (V.C. H34), 1.5 km WSW of Barnesmore village, River Lowerymore, 24 August 1998, *A. Orange* 12502 (NMW C.1998.016.33).

Muellerella pygmaea var. athallina (Müll. Arg.) Triebel (Verrucariaceae)
A taxon with a very wide host spectrum (Triebel 1989), seen once on *Ionaspis lacustris* during the present study.

Specimen examined: **Great Britain:** *Wales*: Merioneth (V.C. 48), Ganllwyd, east side of Afon Mawddach, downstream of Ty'n-y-Groes Hotel, 23/728230, 12 August 1999, *A. Orange* 12618c (NMW C.2001.027.22).

Polycoccum microsticticum (Leighton) Arnold (Dacampiaceae)
Reported on *Ionaspis lacustris* from Greenland and Wales by Alstrup & Hawksworth (1990), also known from other crustose lichens in Europe and North America (Hawksworth & Diederich 1988). No specimens were seen during the present study.

Sagediopsis lomnitzensis (Stein) Orange **comb. nov.** (Adelococcaceae)

Arthopyrenia lomnitzensis Stein in Cohn, *Krypt.-Fl. Schlesien* **2**(2): 343 (1879); type: Poland: Riesengebirge, 'An überfluteten Granitfelsen des Lomnitzfalles im Melzergrunde' [apparently lost]; neotype (here designated): Czech Republic: Sudeti occident. (Krkonoše): in valle rivi 'Mumlava', alt. 1000 m.s.m., supra thallum Jonaspidis odorae ad saxa inundata torrentis, 28.vii.1960, *A. Vězda* [Vězda, *Lichenes selecti exsiccati* no. 28, sub *Arthopyrenia lomnitzensis*] (BM!).

FIGS. 1–2.

Non-lichenized, lichenicolous, at first not affecting appearance of host, later apparently causing the host thallus to become thin and irregular. Vegetative hyphae inconspicuous, colourless, sometimes associated with I + violet material. Perithecia scattered or loosely clustered, immersed in host thallus or hymenium, apex level with thallus surface or often slightly projecting, apex black, plane or slightly convex, up to 120–160 µm diam., ostiole visible as a small depression; in section perithecia to 150–215 µm diam., exciple c. 16-25 µm thick at sides and base, colourless to brown, a thin outer layer 5–8 µm thick often remaining colourless, composed of tangentially compressed cells c. 7–8 × 1.5–3 µm; exciple broadened at apex and here densely pigmented, brown, K + slightly darker. Perithecial wall sometimes I + violet to blue in part. Subhymenium concave. Interascal filaments (paraphysoids) absent to sparse, mainly at the sides of the hymenium, branched and anastomosing, septate, 1.5–2.5 µm wide (lactophenol), segments swollen, sometimes brown when adjacent to exciple; periphyses and periphysoids always present. Hymenial gel I + blue at very low concentrations of I, I + red with higher concentrations (hemiamyloid). Asci fissitunicate, I – , wall thickened above, with ocular chamber, 8-spored. Ascospores ellipsoid, colourless, 1-septate, (9.5–)11–**14.4**–18 × 5–**5.8**–7(-8) µm, (1.4–)1.7–**2.5**–3.2(–3.7) times as long as wide (69 measured); perispore present, gelatinous and rather diffuse in immature ascospores, later firm and difficult to distinguish from spore wall in water, but swelling greatly in K and often apparently with a discrete outer layer, smooth to rough or wrinkled in K, staining in Congo Red. Conidiomata not detected.

Habitat and distribution: On the thallus and in the hymenium of *Ionaspis odora* and *I. lacustris*; specimens seen from Wales, Scotland, Norway, and Czech Republic.

Notes: According to Swinscow (1967) the type of *Arthopyrenia lomnitzensis* is not in WRSL and is believed to have been lost in the Second World War. However, the concept of this species appears to be uniform. Three exsiccatae named as *A. lomnitzensis* were examined; each contain the same taxon, growing on *Ionaspis odora*, and are consistent with a description by Keissler (1938). Although Keissler treated the species as lichenized, his description of the thallus as C + violet and containing a trentopohlioid photobiont suggests *Ionaspis odora*. The description in the protologue is

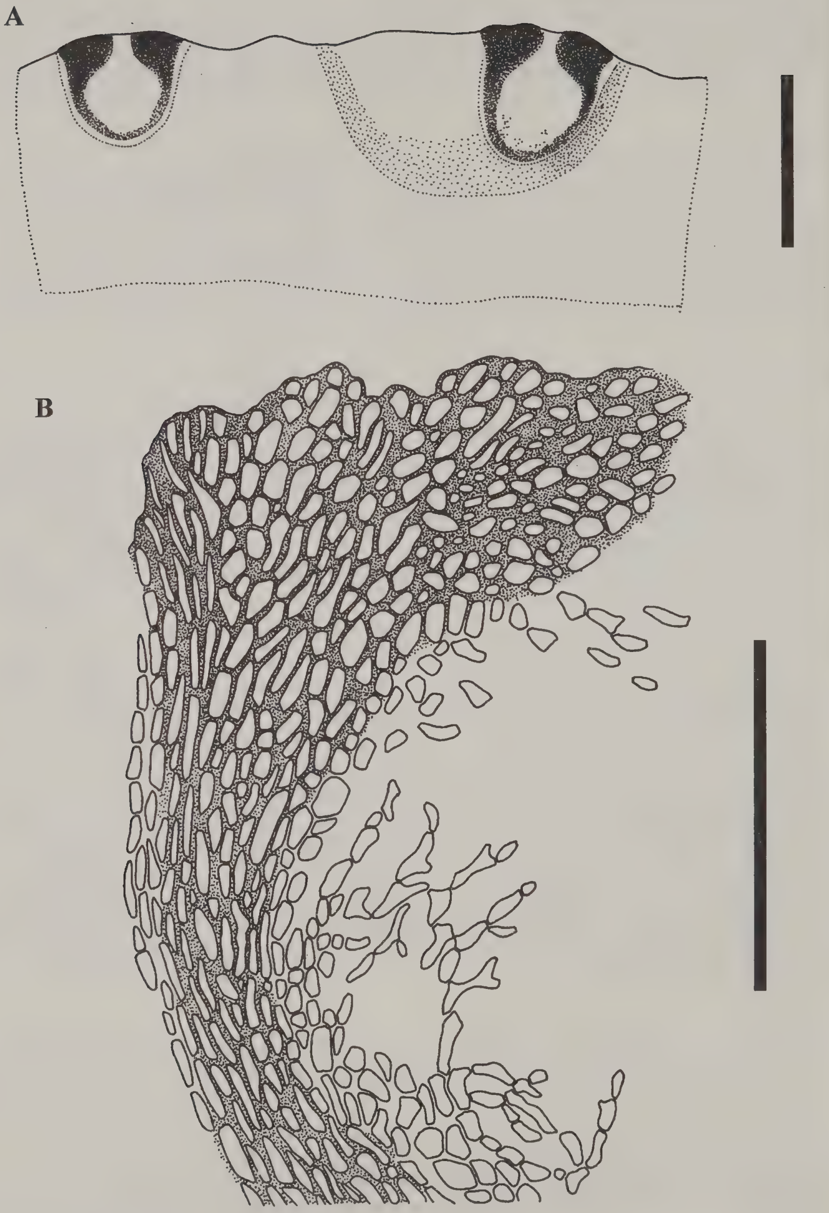

FIG. 1. *Sagediopsis lomnitzensis* (*Orange* 12617). A, perithecia in thallus and (right) apothecia of host. B, part of exciple, showing interascal filaments. Scale A = 200 μm, B = 50 μm.

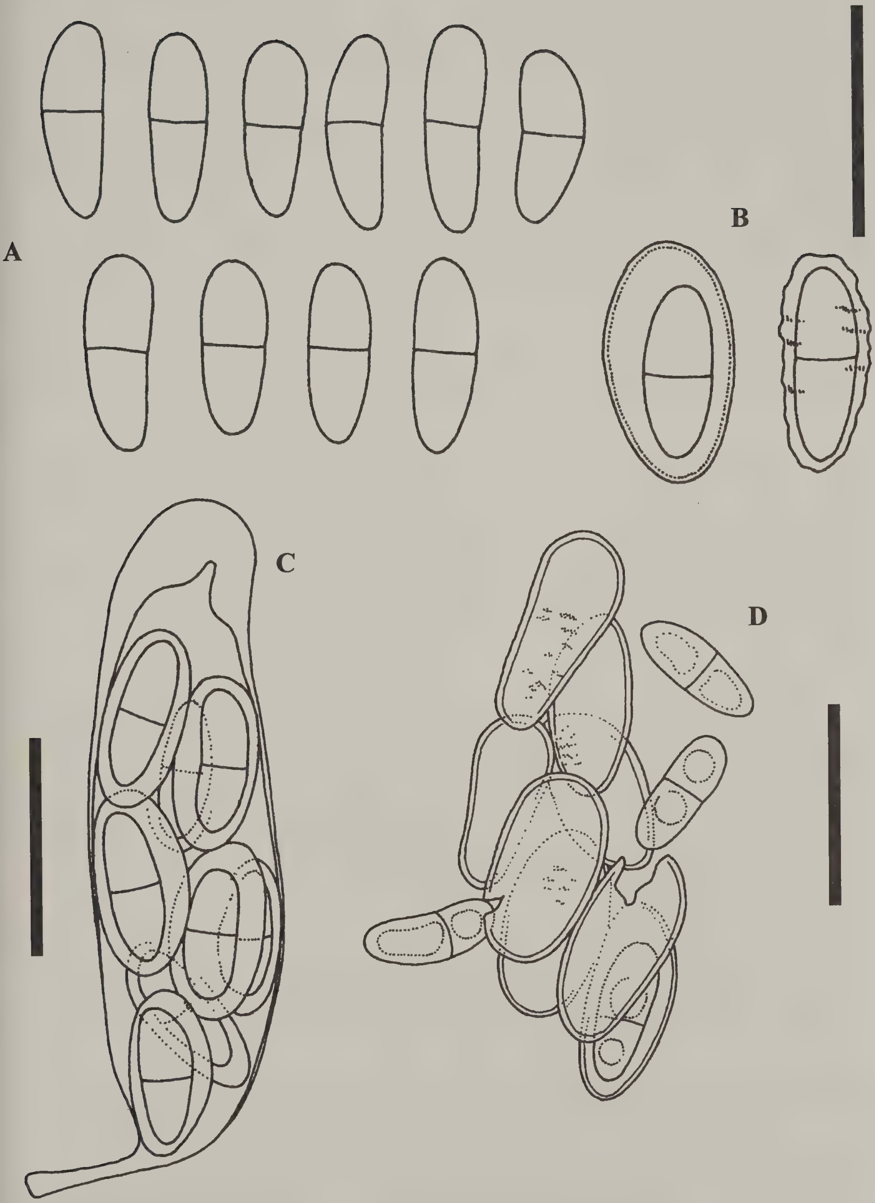

FIG. 2. *Sagediopsis lomnitzensis* (*Orange* 12617). A, ascospores in water. B, ascospores in K. C, ascus in K. D, squash preparation in K, showing ascospores released from perispore. Scales = 20 μm.

brief; the ascospores are said to be 9–12 × 5–6 μm. A neotype is suggested here.

This species is placed here in the genus *Sagediopsis* in the family Adelococcaceae (Verrucariales) due to the non-lichenized condition, hemiamyloid hymenial gel, the presence of interascal filaments in some specimens, the I –, fissitunicate asci, and the exciple thickened above to form a flattened, disc-like apex. A layered exciple is found in some species of the genus; some perithecia of *S. lomnitzensis* also show traces of layering, with the outermost part of the exciple pale. All previously described species of *Sagediopsis* have numerous interascal filaments, but such filaments could be detected in only two specimens of *S. lomnitzensis*. In NMW 44.64.578 filaments were found in some perithecia but not in others. The presence of interascal filaments is an important character which helps to distinguish the Adelococcaceae from the Verrucariaceae, but the present species suggests that the filaments can be reduced or lost within one genus. Interascal filaments are sparse and easily missed even when present, and mounting in Cotton Blue in lactophenol, or staining with Chlorazol Black, is recommended for their detection. The filaments in *S. lomnitzensis* are constricted at the septa, unlike the more or less parellel-sided filaments in other members of the genus.

Minor differences were found between collections on the two different hosts: interascal filaments were never detected in material on *I. odora*, pigment in the exciple was often concentrated at the apex, and I + tissue was usually found in the perithecial wall or in the host thallus. In contrast, material on *I. lacustris* sometimes had sparse interascal filaments, pigment was less concentrated at the apex of the exciple, and I + tissue was found sparingly in only one specimen. These differences are not sufficient to differentiate two taxa at present, but should be re-examined when more material is available.

The ascospores have a perispore which swells very strongly in K. In young ascospores this appears as a gelatinous layer which does not swell strongly in K, but in mature ascospores the perispore is difficult to distinguish from the true wall in water, but swells very strongly in K. The mature perispore in K is often smooth and with a firm surface, but in some it appears rough or wrinkled; it can be separated from the rest of the spore in squash preparations (Fig. 2D). Hoffmann & Hafellner (2000) illustrated a very thick ascospore wall in *Sagediopsis aspiciliae*; it is possible that this is equivalent to the perispore of *S. lomnitzensis*.

Sagediopsis aspiciliae (Vainio) N. Hoffm. & Hafellner differs from *S. lomnitzensis* in the larger perithecia and the 0(–1)-septate ascospores (Hoffmann & Hafellner 2000), *S. dissimilis* Triebel differs in the 0–1-septate, smaller ascospores (7.5–12 μm long); the remaining species of the genus typically have 3-septate ascospores (Triebel 1993).

Additional specimens examined: **Great Britain:** *Wales*: Carmarthenshire (V.C. 44), Ystrad-ffin, rocks in River Towy [Afon Tywi], on *Ionaspis lacustris*, 17 July 1919, *H.H. Knight* (NMW 44.64.578). Merioneth (V.C. 48), Ganllwyd, E side of Afon Mawddach, downstream of Ty'n-y-Groes Hotel, 23/728230, on *Ionaspis lacustris*, 12 August 1999, *A. Orange* 12617 (NMW C.2001.027.19); Ganllwyd, E side of Afon Eden downstream of Pont Dolgefeiliog, 23/722267, on *Ionaspis lacustris*, 13 August 1999, *A. Orange* 12631b (NMW C.2001.027.26). *Scotland*: Mid Perthshire (V.C. 88), Ben Lawers, Lochan nan Cat, 27/644427, alt. 720 m, on *Ionaspis odora*, 21 July 1986, *B.J.*

Coppins 11368, *O.L. Gilbert & B.W. Fox* (E). Angus (V.C. 90), Caenlochan Glen, Craigie Doubs, 37/17.76, alt. 800–850 m, on *Ionaspis odora*, 5 August 1989, *B.J. Coppins* 13393 *& O.L. Gilbert* (E). Westerness (V.C. 97), Creag Meagaidh, NW of summit, 27/407871, alt. 1000 m, on *Ionaspis odora*, 14 September 1994, *A.M. Fryday* 5618 (E). – **Ireland:** Mayo (V.C. H27), Dhulough Pass, on *Ionaspis lacustris*, July 1967, B.J. Coppins (E). – **Norway:** Sogn og Fjordane, Aurland, Kvamsdalen, alt. 1090 m, on *Ionaspis odora*, 20 September 1991, *A. Orange* 8830b (NMW C.2001.027.5). – **Czech Republic:** Bohemia, in montibus 'Riesengebirge', ad saxa inundata in rivulo Koppenbach [on *Ionaspis odora*], *V. Kuták* [A. Zahlbruckner, *Lichenes rariores exsiccati* no. 189, sub *Arthopyrenia lomnitzensis*] (BM). In rivo Bilé Labe, Krkonoše, c. 950 m, [on *Ionaspis odora*], August 1934, *V. Kuták* [K. Kavina & A. Hilitzer, *Cryptogamae čechoslovenicae exsiccatae* no. 263, sub *Arthopyrenia lomnitzensis*] (BM).

Verrucaria conturmatula Nyl. (Verrucariaceae)
Flora **62:** 222 (1879). Type: Ireland, [West Galway], in fluviis prope Kylemore, 1878, *C. Larbalestier* (H-NYL 3498 –holotype!).

FIGS. 3–4.

Non-lichenized; lichenicolous. Forming infected spots up to 3.3 mm diameter on the thallus of the host, the spots at first more or less circular, brown or orange-brown (darker than the uninfected thallus); infected parts becoming thinner than uninfected thallus, then disappearing or falling away. Vegetative hyphae inconspicuous, colourless, elements 3–4 × 1.5-3.5 µm, I – . Perithecia immersed, visible as plane or slightly convex black dots up to 170 µm diameter, often becoming confluent in small groups, forming black areas up to 400 × 400 µm. Exciple 85–140 µm diameter, more or less circular in section; exciple 8–26 µm thick at sides and base, formed of tangentially compressed cells 4–10 × 1.5–5 µm with thickened walls up to 1.5 µm thick; walls colourless or locally brown. Involucrellum present, disc-shaped, extending laterally from apex of perithecium along the surface of the thallus, 85–270 µm diam., 18–35 µm thick, dark brown, often confluent with involucrella of adjacent perithecia. Subhymenium concave. Interascal filaments absent; periphysoids present, short, c. 11–15 µm long, unbranched, 1–3 cells long, of isodiametric to shortly oblong cells; periphyses present . Hymenial gel I + blue at very low concentrations of iodine, I + red at higher concentrations, I + blue after treatment with 10% K (hemiamyloid). Asci 50–55 × 15.5–16.5 µm, fissitunicate, thickened at apex, with ocular chamber, I – , 8-spored. Ascospores irregularly biseriate in the ascus, oblong to oblong-ellipsoid, sometimes slightly constricted, simple (very rarely 1-septate when overmature), colourless, 11.5–**14.0**–16.5 × (4.0–)4.5–**5.5**-6.5 µm, 1.8–**2.6**–3.2(–3.5) times as long as wide (49 measured), wall not thickened, or slightly thickened in some, 0.5–0.8 µm; perispore detected in some, c. 1 µm thick. Conidiomata not seen.

Habitat and distribution: On the thallus of *Ionaspis lacustris*, specimens seen from Ireland, Wales and Scotland.

Notes: The protologue cites the new species as 'Supra saxa quartzosa in rivulo ad

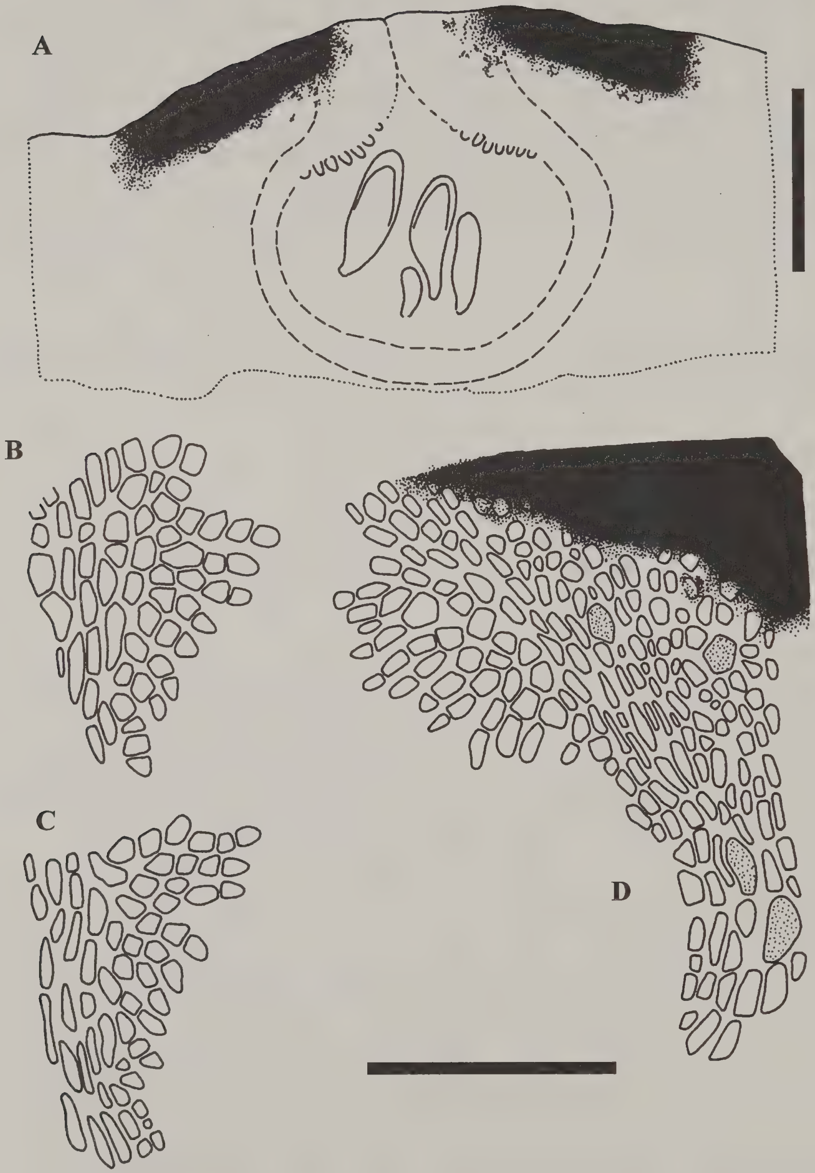

FIG. 3. *Verrucaria conturmatula*. A, perithecium, *Orange* 12616. B, C, periphysoids, *Orange* 12620. D, part of exciple with periphysoids, *Orange* 12631; photobiont cells near exciple are stippled. Scale A = 50 μm, B, C, D = 30 μm.

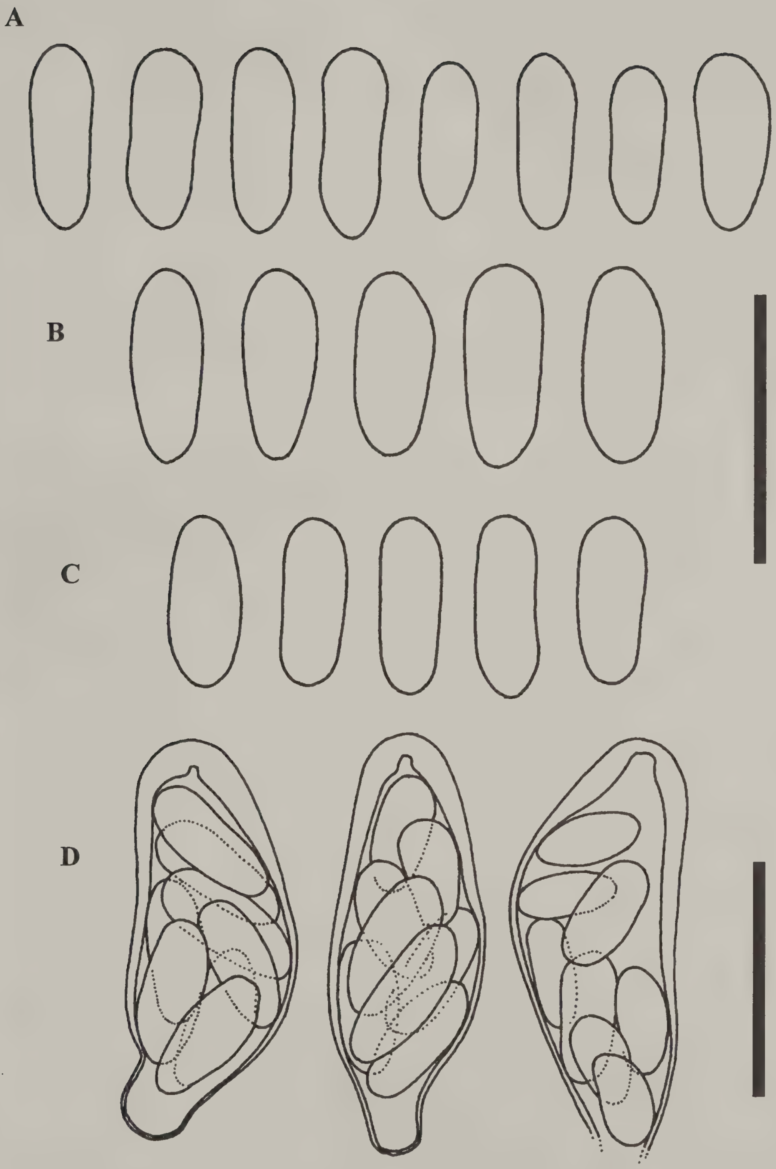

FIG. 4. *Verrucaria conturmatula*. A-C, ascospores (A, *Orange* 7699. B, *Orange* 12143. C, *Orange* 12616). D, asci (holotype). Scales =20 µm.

Kylemore in Hibernia (Larbalestier) inspersa cum *Lecanora lacustri*.' There is only one specimen of *V. conturmatula* in H-NYL, collected at Kylemore and bearing annotations of spore size by Nylander that match those in the protologue. This specimen must be regarded as the holotype. The specimens in BM collected by Larbalestier are annotated with a different locality (although it may possibly have been the same as the holotype locality), and one was collected in 1877; thus neither can be regarded as a type.

Hawksworth (1989) interpreted the holotype, and the two specimens in BM collected by Larbalestier, as immature material of a species of *Polycoccum*. Mature ascospores of *Polycoccum* were found by Hawksworth on the 1878 specimen. However, the holotype comprises mature material of a species with simple, colourless ascospores, and clearly belongs to the same taxon as recently collected material from Wales and Scotland. No *Polycoccum* exists on the holotype. The protologue describes a species with colourless ascospores 11–14 × 5–6 µm, no interascal filaments, and an I + red hymenium, and thus matches the lichenicolous *Verrucaria* present on the holotype. The mention of occasional spores with a rudimentary septum ('interdum obsolete 1-septatae') is regarded as due to the presence of over-mature ascospores.

This species is placed in the genus *Verrucaria* due to the hemiamyloid hymenial gel, absence of interascal filaments, presence of periphysoids, and I –, fissitunicate asci. The species of *Verrucaria* are usually considered to be lichenized, even when growing on other lichens, but *V. conturmatula* is a parasite which kills the host and does not form its own thallus. In all other features, however, it resembles *Verrucaria*, and the absence of lichenization is in itself not sufficient to require a separate genus. *Telogalla* (Hoffmann & Hafellner 2000) is a monotypic genus which differs from *Verrucaria* in the non-lichenized, gall-forming habit. However, *V. conturmatula* differs from *T. olivieri* in the pigmented exciple and the presence of an involucrellum, features which are frequent in *Verrucaria*.

Approximately 12 lichenicolous species of *Verrucaria* are known (Zehetleitner 1978, Clauzade & Roux 1984, 1985, Hoffmann & Hafellner 2000). *V. conturmatula* differs from all these in the lack of a thallus, the presence of an involucrellum, and the smaller perithecium.

Additional specimens examined: **Great Britain:** *Wales*: Cardiganshire (V.C. 46), Devil's Bridge, Coed Erw-barfau, 22/745781, 3 August 1989, *A. Orange* 7699 (NMW C.2001.027.3). Merioneth (V.C. 48), NW of Dinas Mawddwy, Nant y Graig-wen, 23/833170, alt. 270 m, 17 May 1998, *A. Orange* 12143 (NMW C.2001.027.14); Ganllwyd, E. side of Afon Mawddach, downstream of Ty'n-y-Groes Hotel, 23/728230, 12 August 1999, *A. Orange* 12616 (NMW C.2001.027.18); Ganllwyd, E. side of Afon Mawddach, downstream of Ty'n-y-Groes Hotel, 23/730229, *A. Orange* 12620 (NMW C.2001.027.23); Ganllwyd, E. side of Afon Eden downstream of Pont Dolgefeiliog, 23/722267, 13 August 1999, *A. Orange* 12631a (NMW888). Caernarvonshire (V.C. 49), Pass of Llanberis, Afon Las, below Pistyll Gwyn, 23/629580, alt. 320 m, 15 May 1998, *A. Orange* 12105b (NMW C.2001.027.13). *Scotland*: Lanarkshire (V.C. 77), Leadhills, Shortcleuch Water, Gold Scours, 26/90.16, 8 December 1991, *B.J. Coppins* 14796 & *A.M. O'Dare* (E). Perthshire (V.C. 88), Glen Lyon, Allt Bail a' Mhuilinn, 27/580415, alt. 470 m, 12 September 2001, *A. Orange* 13143 (NMW C.2001.027.44). – **Ireland:** ?West Galway (V.C. H16), river near Glencorbet, Connemara, 1878, *C. Larbalestier*

(BM); in a stream near Glencorbet, Connemara, 1877, *C. Larbalestier* (BM).

Zwackhiomyces lacustris (Arnold) Orange **comb. nov.** (Xanthopyreniaceae)

Thelidium lacustre Arnold, *Verhandl. Zool.-Bot. Ges. Wien* **43:** 388 (1893); type: Austria: Phyllitblöcke im Alpenbache bei St. Christoph auf dem Arlberg, Tirol, [on *Ionaspis lacustris*], July 1890, *F. C. G. Arnold* (M – holotype!). – *Pharcidia lacustris* (Arnold) Zopf, *Hedwigia* **35:** 317 (1896). – *Tichothecium lacustre* (Arnold) Magnus in Dalla Torre & Sarnth., *Fl. Tirol* **3:** 459 (1905). – *Sphaeria lacustris* (Arnold) H. Olivier, *Les principaux parasites de nos lichens français. Suppl.:* 15 (1907).

FIGS. 5–6.

Non-lichenized, lichenicolous, causing the host to change colour slightly, from pale orange (uninfected) to pale brown or whitish brown; in one specimen hymenium of host lost. Perithecia immersed in the host thallus, then erumpent, eventually slightly projecting, often splitting the host cortex, visible part black, matt, convex, up to 200 µm diameter. Perithecium in section 195 µm high and 165 µm diameter (one measured). Exciple 23–25 µm thick, not thickened above, pigmented except at base, or only near apex, cells mostly lightly tangentially compressed, 5–15 × 3.5–9 µm, unpigmented cells thin-walled, pigmented material unevenly deposited along wall, sometimes granular at first, coalescing to form dense masses of pigment, outer cells of exciple often obscured. Hamathecium of numerous branched and anastomosing paraphysoids 1.5–3(–4) µm wide in K/Congo Red, elements more or less cylindrical, not swollen, septa frequent. Free ends of a few paraphysoids near to ostiole sometimes with slightly browned walls. Periphysoids and periphyses absent. Asci clavate, wall thickened above, with small ocular chamber in water and in K; wall I – , ascus sap I + red-brown, hymenial gel I – ; asci apparently fissitunicate; expanded endotunica seen in broken immature asci, but no mature dehisced asci detected. Ascospores 8 per ascus, irregularly biseriate, ellipsoid, 23–**27.1**–31 × 9.0–**10.2**–12 µm, 2.1–**2.7**–3.2 times as long as wide (19 measured), colourless, 1-septate (a few 3-septate ?abnormal ascospores seen in one specimen), slightly constricted at septum, thin-walled (wall c. 0.5 µm), with 1–2 large oil drops and some small drops in each cell (in material 4 years old), upper cell slightly longer and wider than lower cell; perispore present, easily visible on immature ascospores both within ascus and on free ascospores, 1–3 µm thick in water, sometimes delicate and difficult to see on free ascospores in water, up to c. 4 µm thick in K (material c. 4 years old), smooth or finely roughened in colourless ascospores, eventually becoming brown and verrucose. Conidiomata not seen.

Habitat and distribution: on thallus and in hymenium of *Ionaspis lacustris*, specimens seen from Austria, Wales and S.W. England.

Notes: This species is placed here in *Zwackhiomyces* due to the branched and anastomosing interascal filaments, the I – hymenium, the fissitunicate asci, the 1-septate ascospores with the upper cell often larger than the lower, and the rough perispore. The species is distinguished from other species in the genus by the larger ascospores and the identity of the host. The available material of this species was sparse and the description is incomplete; the holotype comprises only a few perithecia, and the description of the exciple is based mainly on *Orange* 12358. The perispore becomes brown and distinctly verrucose in the holotype and in the specimen from Devon, but no brown or roughened

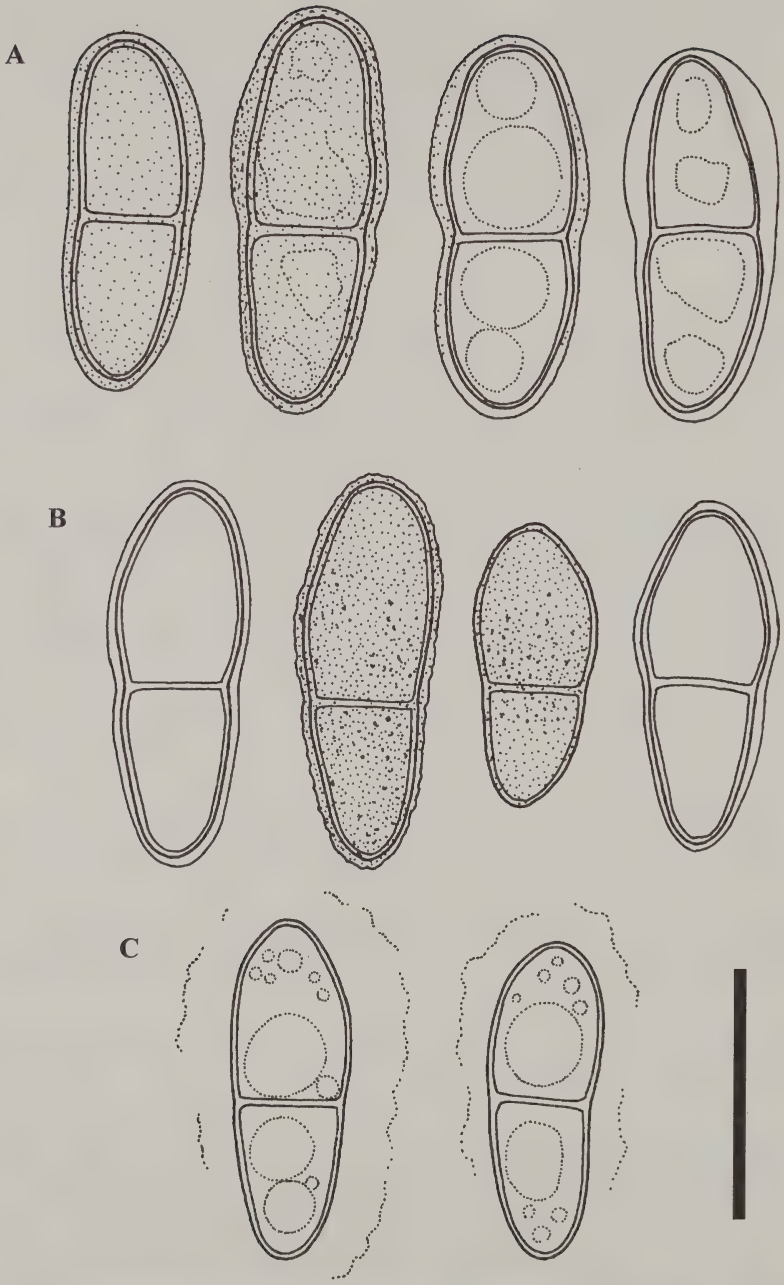

FIG. 5. *Zwackhiomyces lacustris*. Ascospores. A, holotype. B, *Davies*, Tavy Cleave. C, *Orange* 12358. Scale = 20 µm.

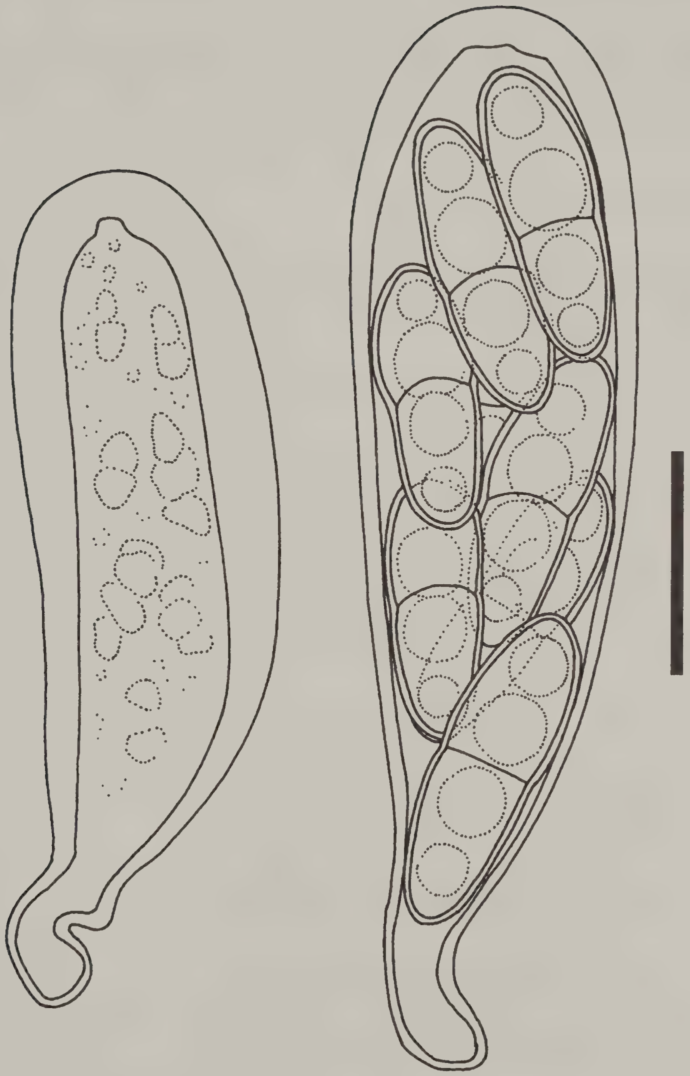

FIG. 6. *Zwackhiomyces lacustris*. Immature (left) and mature (right) asci in water, *Orange* 12358. Note perispore surrounding each ascospore. Scale = 20 µm.

See Errata

perispore was seen in *Orange* 12358, possibly due to immaturity. There is little doubt, however, that the three specimens belong to the same species. Other species of *Zwackhiomyces* have colourless ascospores, but the perispore eventually becomes slightly brownish in some species (Grube & Hafellner 1990).

Additional specimens examined: **Great Britain:** *Wales*: Caernarvonshire, Pass of Llanberis, Afon Las, 23/624581, alt. 550 m, 23 June 1998, *A. Orange* 12358 (NMW C.2001.027.16). *England*: South Devon (V.C. 3), [Dartmoor, near Mary Tavy,] Tavy Cleave, [20/55.83, no date, but before 1892] *G. Davies* (BM, sub *Ionaspis lacustris*).

Excluded species

Guignardia psoromoides was recorded on *Ionaspis lacustris* by Alstrup *et al.* (1994), but this name is a synonym of *Catapyrenium psoromoides* according to Hoffmann & Hafellner (2000). The specimen on which the record was based could not be traced in C.

Key to lichenicolous fungi reported from *Ionaspis lacustris* in Europe

1 Ascospores 3-septate, colourless; asci with small I + blue tube structure in tholus; ascomata perithecioid but ostiole often gaping .... *Kallalia reactiva*
1 Ascospores 0–1-septate, colourless or brown; asci without I + structures 2
2 (1) Hymenial gel inamyloid; interascal filaments present; ascospores 1-septate 3
2 Hymenial gel hemiamyloid (I + red, after treatment with K, I + blue); interascal filaments present or absent 4
3 (2) Ascospores 14–18 × 7–8.5 µm, brown, verruculose .... *Polycoccum microsticticum*
3 Ascospores 23–31 × 9.0–12 µm, colourless, but perispore eventually becoming brown and verruculose .... *Zwackhiomyces lacustris*
4 (2) Ascospores simple, colourless, interascal filaments absent, involucrellum present .... *Verrucaria conturmatula*
4 Ascospores 1-septate, colourless or brown, interascal filaments present or absent, involucrellum absent 5
5 (4) Asci polysporous; ascospores brown, 1-septate .... *Muellerella lichenicola*
5 Asci 8-spored 6
6 (5) Ascospores colourless, with perispore which swells greatly in K at maturity, interascal filaments sometimes present but easily overlooked .... *Sagediopsis lomnitzensis*
6 Ascospores brown, interascal filaments absent 7
7 (6) Ascospores verrucose, (9–)9.5–13.5(–14.5) × 5.5–7.5(–8) µm .... *Endococcus verrucosporus*
7 Ascospores smooth, 12–16(–18) × (5–)7(–9) µm .... *Endococcus rugulosus*

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I would like to thank Dr B. J. Coppins (E), Dr E. S. Hansen (C) and Dr D. Triebel (M) for searching for specimens or making literature available.

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GLOMUS LAMELLOSUM (GLOMALES, ZYGOMYCOTA), AN ARBUSCULAR MYCORRHIZAL FUNGAL SPECIES NEW FOR POLAND AND EUROPE

Janusz Błaszkowski, Iwona Adamska
and Tadeusz Madej

Department of Plant Pathology, University of Agriculture,
Słowackiego 17, PL-71434 Szczecin, Poland
E-mail: jblaszkowski@agro.ar.szczecin.pl

Abstract

Morphological properties of spores of *Glomus lamellosum* (Glomales, Zygomycota), an arbuscular mycorrhizal fungus for the first time found in Poland and Europe, are described and illustrated. Additionally, the characteristics of the mycorrhizae formed by this fungus in one-species pot cultures with *Plantago lanceolata* as the plant host are presented. *Glomus lamellosum* produced yellowish white to light yellow ectocarpic spores with a 3-layered wall: a hyaline, semipermanent outermost layer forming a halo under reflected light, a yellowish white to light yellow, laminate middle layer, and a very thin, hyaline, flexible innermost layer staining pinkish white to pastel red in Melzer's reagent. The mycorrhizae formed by this fungus in *P. lanceolata* roots comprised arbuscules, vesicles, as well as intra- and extramatrical hyphae; all the structures stained darkly in trypan blue. *Glomus lamellosum* was found in six soil samples coming from maritime sand dunes adjacent to Świnoujscie in northwestern Poland and in six soils collected from inland dunes of the Błędowska Desert located in the south of this country. This fungus was earlier encountered only in sandy habitats of the Great Lakes region of Canada and U.S.A.

Key Words: arbuscular mycorrhizae, distribution, sand dunes

Introduction

Glomus lamellosum Dalpé, Koske & Tews, an arbuscular mycorrhizal fungus of the order Glomales (Zygomycota), has so far been known only from the original description prepared based on spores isolated from under *Ammophila breviligulata* Fern colonizing a sandy shore of Nottawasaga Bay in Georgian Bay, Ontario, Canada and sand dunes of Bailey's harbor, Wisconsin, U.S.A. (Dalpé et al. 1992). However, following the examination of spores of this fungus from four ex-type cultures, Walker and Vestberg (1998) concluded that the definition of *G. lamellosum* should be corrected.

Investigations of spores of arbuscular mycorrhizal fungi isolated from both field-collected rhizosphere soil-root mixtures taken from under maritime and inland dune plants and pot trap cultures with these mixtures revealed the presence of *G. lamellosum* in Poland. This fungus was subsequently propagated in one-species pot cultures with *Plantago lanceolata* L. as the plant host.

The aim of this paper is to describe and illustrate the spores of *G. lamellosum* found in Poland and the mycorrhizae formed by this fungus in roots of *P. lanceolata*.

Materials and Methods

Collection of soil samples, establishment of trap and single-species pot cultures, as well as growth conditions generally are as those described previously (Błaszkowski and Tadych 1997). Briefly, rhizosphere soils and roots of sampled plants were collected from a depth of 5-30 cm using a small garden shovel. In the laboratory, about 200-g subsamples were taken from each sample to determine the species of arbuscular fungi sporulating in the field. Then, the remaining soil-root mixtures were either air dried for 2 weeks and subsequently refrigerated at 4°C or directly used to establish trap cultures. Trap cultures were established to receive a great number of living spores of different developmental stages and to initiate sporulation of non-sporulating species in the field conditions. The growing substrate of the trap cultures was the field-collected material mixed with an autoclaved sand coming from maritime dunes adjacent to Świnoujście (pH 6.7; 12 and 26 mg L^{-1} P and K, respectively). These mixtures were placed in 15-

cm plastic pots (1350 cm^3) and seeded with *P. lanceolata* as the plant host. At least 100 seeds were added to each pot. Plants were grown in a greenhouse at 15-30°C with supplemental 8-16-h lighting provided by one SON-T AGRO sodic lamp (Philips Lighting Poland S. A.) placed 1 m above pots. The maximum light intensity was 180 $\mu E\ m^{-2}s^{-1}$ at pot level. Plants were watered 2-3 times a week. No fertilization was applied during the growing period. Trap cultures were harvested at approximately 1-month intervals, beginning 3 months and ending 11 months after plant emergence. Spores were extracted by wet sieving and decanting (Gerdemann and Nicolson 1963). Presence of mycorrhizae was determined following clearing and staining of roots. Based on the experience of the authors of this paper and suggestions of Professor R. E. Koske, Rhode Island University, U. S. A., two changes were introduced to the original method given by Phillips and Hayman (1970). First, roots earlier cleared in 10% KOH were acidified in 20% HCl instead of 1% HCl as in the original procedure. Second, the concentration of trypan blue was increased from 0.05% to 0.1%.

Single-species pot cultures were established from about 50 to 100 newly formed spores stored before inoculation in water at 4°C for 24 h. After removing soils debris, they were collected in a pipette and transferred onto a compact layer of roots of 10-14-day-old seedlings of *P. lanceolata* placed at the bottom of a hole of *ca* 1 cm wide and 4 cm deep formed in a wetted growing medium filling 8-cm plastic pots (250 cm^3). The growing medium was an autoclaved sand of maritime dunes adjacent to Świnoujście of chemical properties given above. Subsequently, the spores were covered with another layer of roots coming from 4-6 plants of the host. Finally, the roots and sandwiched spores were buried in the growing medium. The cultures were harvested after 4-12 months and spores extracted. The effectiveness of the method of establishment of one-species cultures described above usually exceeded 90%.

Developmental stages of the fungus were determined based on newly formed spores extracted from both trap and single species cultures, the latter being harvested at *ca* 20-30-day intervals.

Morphological properties of spores, their subcellular structures and developmental stages during differentiation were determined based on at least 100 spores mounted in polyvinyl alcohol/lactic acid/glycerol (PVLG; Koske and Tessier 1983) and a mixture of PVLG and Melzer's reagent (1:1, v/v). The spores represented all stages of differentiation of the fungus. The degree of maturity of spores was assessed based on their appearance under an Olympus SZX9 dissecting microscope. The main properties considered were color and size of spores. Spores were crushed to varying degrees by applying pressure to the coverslip and then stored at 65°C for 24 h to clear their contents from oil droplets. Examination of such prepared specimens was performed using an Olympus BX50 compound microscope equipped with differential interference contrast optics.

Terminology of spore structure is that suggested by Spain et al. (1989), Stürmer and Morton (1997), and Walker (1983). Spore color was examined under a dissecting microscope on fresh specimens immersed in water. Color names are from Kornerup and Wanscher (1983). Specimens were mounted in PVLG on slides and deposited in the Department of Plant Pathology (DPP), University of Agriculture, Szczecin, Poland.

Description of the species

Glomus lamellosum Dalpé, Koske & Tews

Figs. 1-8

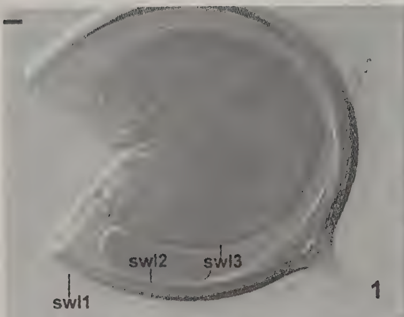
Sporocarps unknown. Spores borne singly in the soil; produced from straight sporophores. *Sporophore* coenocytic to sparsely septate; hyaline; (5.4-)6.1(-9.3) µm wide; with a wall 0.7-1.0 µm thick; bearing spores by swelling at hyphal tips (Fig. 6). *Spores* yellowish white (4A2) to light yellow (4A4-6); globose to subglobose; (60-)100(-140) µm diam; sometimes ovoid; 80-110 x 120-160 µm; with a single subtending hypha (Figs. 1, 5, 6). *Subcellular structure of spores* consists of one wall (Figs. 1-5) with three layers (layers 1-3). Outermost layer 1 hyaline, (2.2-)5.3(-10.5) µm thick, forming a halo under reflected light when not deteriorated, slowly decomposing beginning from its outer surface (Fig. 2, 5), present in most mature spores. Layer 2 laminate, yellowish white (4A2) to light yellow (4A4-6), (2.0-)4.2(-5.6) µm thick. Layer 3 flexible, hyaline, 0.2-0.5 µm thick, sometimes separating from layer 2 in vigorously crushed spores, usually attached to the surface of the lumen of subtending hypha, staining pinkish white (7A2) to pastel red (9A4) in Melzer's reagent (Figs.

1, 4). The wall of most juvenile spores consists of layer 1 only (Fig. 6). Layers 2 and 3 form successively with spore maturation, the termination of which determines the staining reaction of layer 3 in Melzer's reagent. *Subtending hypha* hyaline to light yellow (4A4-6); straight or recurvated; mostly flared (Figs. 1, 5, 6), sometimes cylindrical, rarely constricted; (8.3-)13.0(-15.2) µm wide at the spore bases. *Wall of subtending hypha* hyaline to light yellow (4A4-6); (3.9-)5.6(-8.3) µm thick at the spore base; continuous with spore wall layers 1 and 2 (Fig. 5). Pore (1.5-)4.7(-10.3) µm wide, occluded by an invagination formed by spore wall layer 3.

Collections examined: POLAND. Szczecin, spores from one-species pot culture with *P. lanceolata* as the plant host, 25 June 1999, *J. Błaszkowski, 2322-2339* (DPP).

Other materials examined. POLAND. Świnoujście (53°55'N, 14°14'E), spores from two field-collected soils from under *Ammophila arenaria* Link, 22 Sept. 1992 and 22 Sept. 1997, *Błaszkowski, J., unnumbered collections* (DPP); spores from trap cultures with rhizosphere soils of *A. arenaria*, 22 Sept. 1992, *Błaszkowski, J., unnumbered collection* (DPP); *Corynephorus canescens* (L.) P. Beauv., 13 June 1997, *Błaszkowski, J., cultures 1290, 1292, 1294, 1295* (DPP). The Błędowska Desert (50°22' N, 19°34' E), spores from trap cultures with soils from under *Holcus mollis* L., 26 June 1997, *Błaszkowski, J., cultures 1235, 1238, 1251, 1260, and 1267*; *Leymus arenarius* L., 26 June 1997, *Błaszkowski, J., culture 1271* (DPP).

Figs. 1-6. Spores of *Glomus lamellosum*. 1. Adherent spore wall layers 1 and 2 (swl1, 2) and a separated, stained spore wall layer 3 (swl3) of a spore crushed in Melzer's reagent. 2. Slightly deteriorated surface of the thick spore wall layer 1 (swl1) separated from the laminate spore wall layer 2 (swl2) to which spore wall layer 3 (swl3) adheres. 3. Spore wall layers 1-3 (swl1-3) of a spore crushed in Melzer's reagent; note the deeper deteriorated layer 1. 4. Highly deteriorated spore wall layer 1 (swl1) adherent to the laminate spore wall layer 2 (swl2) and separated spore wall layer 3 (spwl3) stained darkly in a spore crushed in Melzer's reagent. 5. Spore wall layers 1-3 (swl1-3) and flared subtending hypha with subtending hyphal wall layers 1 and 2 (shwl1, 2); note the invaginated spore wall layer 3 forming a septum (s) occluding the lumen (l) of subtending hypha. 6. Most juvenile spore. Figs. 7 and 8. Mycorrhizae of *Glomus lamellosum* in roots of *Plantago lanceolata* stained in 0.1% trypan blue. 7. Arbuscules (arb), intramatrical (ihyp) and extramatrical hyphae (ehyp). 8. Vesicles (ves) and intramatrical hyphae (ihyp). All differential interference contrast. Bars, all 10 µm.


1
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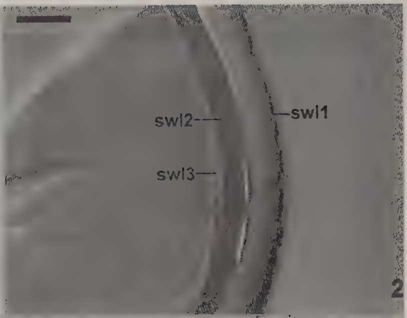
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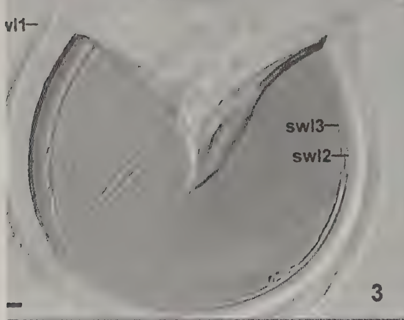
3
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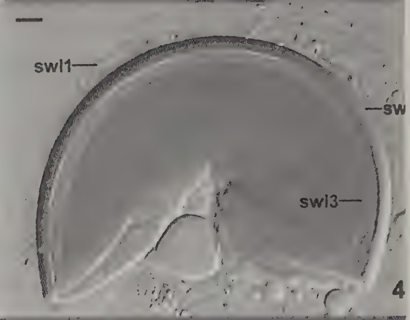
4
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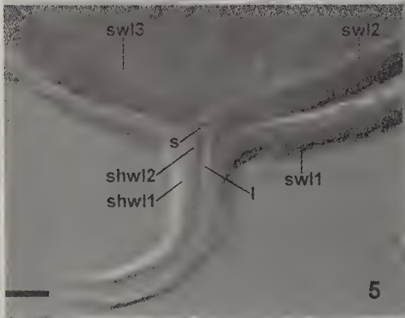
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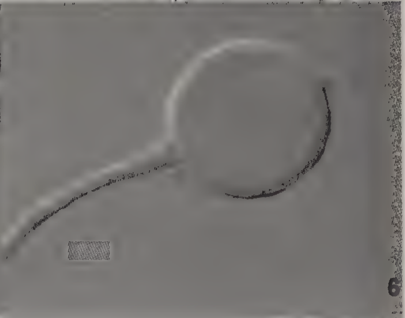
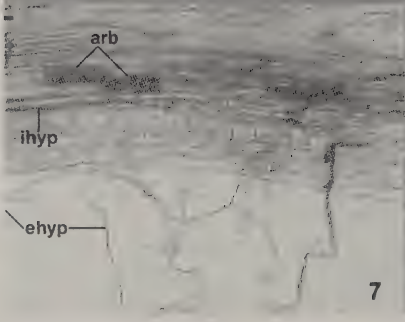

6


7
arb
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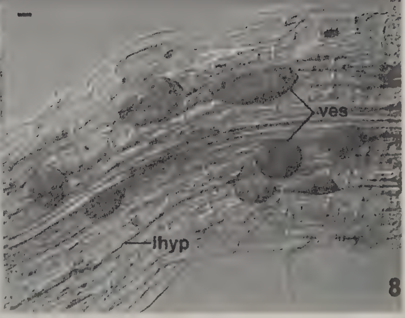
ehyp


8
ves
ihyp

Distribution and habitat. Spores of *G. lamellosum* were found in two field-collected rhizosphere soils of *A. arenaria* colonizing maritime dunes adjacent to Świnoujście and 10 trap cultures with soil-root mixtures that did not harbour spores of this fungus in the field. The mixtures came from under *C. canescens* (3 samples) and *Hieracium pilosella* L. (1 sample) growing in dunes of Świnoujście and from under *H. mollis* (5 samples) and *L. arenarius* (1 sample) colonizing inland dunes of the Błędowska Desert in the south of Poland.

The spore numbers of *G. lamellosum* in the two field soils were 62 and 1 in 100 g dry soil. The arbuscular mycorrhizal fungal species densities in the two field soils were 2 and 3 in 100 g dry soil.

The concomitant arbuscular fungal species of *G. lamellosum* in the Świnoujście field soils or trap cultures were: *Acaulospora trappei* Ames & Linderman, *Glomus arenarium* Błaszk. et al., *G. corymbiforme* Błaszk., *G. etunicatum* Becker & Gerd., *G. fasciculatum* (Thaxter) Gerd. & Trappe emend. Walker & Koske, *G. macrocarpum* Tul. & Tul., *G. minutum* Błaszk. et al., *G. trimurales* Koske & Halvorson, *Scutellospora armeniaca* Błaszk., *S. dipurpurescens* Morton & Koske, *S. pellucida* (Nicol. & Schenck) Walker & Sanders, and *S. persica* (Koske & Walker) Walker & Sanders. The fungi co-occurrring with *G. lamellosum* in the Błędowska Desert included *A. lacunosa* Morton, *A. mellea* Spain & Schenck, *A. rugosa* Morton, *A. trappei*, *Gigaspora gigantea* (Nicol. & Gerd.) Gerd. & Trappe, *G. aggregatum* Schenck & Smith emend. Koske, *G. clarum* Nicol. & Schenck, *G. etunicatum, G. intraradices* Schenck & Smith, *G. macrocarpum, G. microcarpum* Tul. & Tul., undescribed *Glomus* 129 and *Glomus* 142, *S. armeniaca, S. dipurpurescens, S. pellucida,* and *S. persica*.

The soil chemical properties of the Świnoujście dunes were: pH(H_20), 3.8-6.7; NO_3 (mg L^{-1}), 20-72; P, 5-12; K, 2-26; Mg, 10-41; Na, 4-23; Cl, 15-25; KCl, 0.1-0.6; organic C(%), 0.1-1.1 (Błaszkowski, 1995). The soil chemical properties of the Błędowska Desert dunes ranged: pH, 5.6-5.9; NO_3 (mg L^{-1}), 9.3-10.8; P, 3-5; K, 5-13; Mg, 7-23; Na, 0-1; Cl, 13.7-18.2; KCl (g L^{-1}), 0.060-0.075; organic C(%), 0.27-0.42.

Mycorrhizal associations. In the field, *G. lamellosum* was associated with vesicular-arbuscular mycorrhizal roots of *A.*

arenaria, C. canescens, Hi. pilosella, H. mollis, and *L. arenarius.* The mycorrhizae formed in single-species cultures of this fungus with *P. lanceolata* as the plant host consisted of arbuscules, vesicles, as well as intra- and extramatrical hyphae (Figs. 7, 8). Arbuscules were irregularly distributed and had fine branches difficult to see. Vesicles were 21.8-34.3 x 51.7-83.4 µm and usually occurred in conglomerations highly scattered along roots. Intramatrical hyphae were 3.4-5.9 µm wide and grew parallel to the root axis. These hyphae sometimes formed coils, 18.4-20.3 x 33.8-46.6 µm and Y-shaped branches. Extramatrical hyphae were 5.1-6.9 µm wide. In 0.1% trypan blue, arbuscules stained violet grey (18B2-18C3), vesicles greyish violet (18B3), intramatrical hyphae, coils, and extramatrical hyphae greyish violet (18B4, 18B3-18E5, and 18B4-18C6, respectively).

Discussion

Taxonomic analysis. The properties most distinguishing spores of *G. lamellosum* are their thick, hyaline, relatively permanent outermost wall layer (layer 1) producing a halo in reflected light (Figs. 1-3, 5) and the flexible innermost wall layer (layer 3) staining pinkish white to pastel red in Melzer's reagent (Figs. 1-5).

The differentiation of spore wall of *G. lamellosum* comprises successive formation of discrete layers, beginning from the outermost layer 1. This pattern correspond with that found in all *Glomus* spp. investigated ontogenetically to date (e. g., Błaszkowski and Tadych 1997; Stürmer and Morton 1997).

With age, layer 1 gradually deteriorates (Fig. 2-4), beginning from its outer surface (Fig. 2) and, thereby, looses transparency. However, it is present in most even old spores.

Spore wall layer 2 consists of tightly adherent, very thin sublayers (laminae). It forms *de novo* after the formation of layer 1 is completed.

The innermost spore wall layer 3 always tightly adheres to the laminate layer 2 (Figs. 2, 3, 5). Only vigorous crushing of spores sometimes separates layer 3 from layer 2 (Figs. 1, 4). However, the presence of layer 3 most reveals its staining reaction in Melzer's reagent. The intensity of staining of layer 3 in Melzer's reagent varies in different spores and probably depends on the stage of development of this layer, as found in, e. g., *Entrophospora colombiana* Spain & Schenck (Stűrmer and Morton 1999).

The arbuscular mycorrhizal fungi most resembling *G. lamellosum* are *G. claroideum* Schenck & Smith, *G. clarum*, and *G. luteum* Kennedy, Stutz & Morton. All these fungi form yellow-colored spores of a more or less overlapping size range (Dalpé et al. 1992; Kennedy et al. 1999; Morton 2000; Schenck and Smith 1982; Stürmer and Morton 1997).

The main differences between the four fungal species are the number and properties of the spore wall and subtending hyphal wall components. The spore wall of *G. lamellosum* consists of three layers (Dalpé et al. 1992; Morton 2000; pers. observ.), whereas that of *G. claroideum* and *G. luteum* comprises four layers (Kennedy et al. 1999; Stürmer and Morton 1997). *Glomus lamellosum* does not differentiate a mucilaginous outermost layer staining in Melzer's reagent as do the letter two species. Additionally, the outer hyaline layer of *G. lamellosum* spores is much more persistent than that of the two outer hyaline spore wall layers of *G. claroideum* and *G. luteum.* It is especially evident in *G. claroideum*, in which these layers usually are completely sloughed in mature spores.

The most important structure grouping *G. lamellosum* with *G. claroideum* and *G. luteum* is the flexible innermost wall layer of their spores. Although it is phenotypically identical in the three fungi, it stains in Melzer's reagent only in *G. lamellosum* (Kennedy et al. 1999; Morton 2000; Stürmer and Morton 1997). The reactivity of a flexible innermost spore wall layer infrequently occurs in other *Glomus* spp. (Morton 2000; pers. observ.). Additionally, the degree of adherence of this layer to the laminate structural spore wall layer highly differs in these species: it adheres to the laminate layer in most crushed spores of *G. lamellosum*, but separates readily from it in the other two species.

Although spores of *G. clarum* also have a three-layered wall and a halo in reflected light, those of *G. lamellosum* neither possess the mucilaginous outermost wall layer (staining in Melzer's reagent) nor their halo is produced by a hyaline, laminate wall layer as found in *G. clarum* (Stürmer and Morton 1997).

Differences between the four *Glomus* spp. compared here also reside in the structure of wall of their subtending hyphae. The wall of subtending hypha of *G. lamellosum* is two-layered, whereas it consists of three layers in the other fungal species considered.

Finally, the mycorrhizae of *G. lamellosum*, *G. claroideum*, and *G. luteum* are similar: they stain darkly in trypan blue, and vesicles are formed sporadically. In contrast, despite the mycorrhizal structures of *G. clarum* that also stain intensively in trypan blue, this fungus frequently forms intraradical vesicles (Morton 2000).

Distribution. *Glomus lamellosum* has so far been known only from the sites listed in its original description (Dalpé et al. 1992). This fungus was associated with *A. breviligulata* colonizing a sandy shore of Nottawasaga Bay in Georgian Bay, Ontario, Canada and sand dunes of Bailey's harbor, Wisconsin, U.S.A. This paper for the first time informs of the occurrence of *G. lamellosum* in Europe.

Acknowledgment

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NOTES ON HYPHOMYCETES. LXXXV. JUNEWANGIA, A GENUS IN WHICH TO CLASSIFY FOUR ACRODICTYS SPECIES AND A NEW TAXON

WILLIAM A. BAKER, E. CHRISTOPHER PARTRIDGE
AND GARETH MORGAN-JONES

Department of Entomology and Plant Pathology, College of Agriculture,
Auburn University, Alabama 36849

ABSTRACT

The current taxonomic condition and status of *Acrodictys* is reviewed and found to be unduly heterogeneous. Consideration is given to a number of taxa which are thought to be unsatisfactorily accommodated in this genus and the need for alternative classification thereof is discussed. Four species, *A. globulosa*, *A. lamma*, *A. martinii*, and *A. obliqua,* together with a newly-discovered entity, are placed in a novel, segregate genus, *Junewangia.* The *Acrodictys* generic concept is refined in a stricter sense, an emended description is provided, and its type species, *A. bambusicola*, and two other similar taxa, *A. atroapicula* and *A. elaeidicola*, are treated in order to more clearly define, delineate, and particularize the hallmark characteristics of the genus.

KEYWORDS: Generic concepts, *Selenosporella*-like synanamorphs.

INTRODUCTION

As briefly discussed in a preceding paper of this series (Baker *et al.*, 2001), the genus *Acrodictys* M.B. Ellis has been, from its inception, somewhat heterogeneous in nature. Moreover, with the addition of a considerable number of new taxa, it has become progressively more so. In fact, it is probably true to say that the genus now contains so many disparate elements that a critical revision is highly desirable. As has historically been the case with many other broadly-defined anamorph form-genera, such as

Endophragmia Duvernoy & Maire, *Pseudospiropes* M.B. Ellis, and *Sporidesmium* Link, *Acrodictys* has become a repository for a variety of entities not readily accommodated elsewhere. Thereby, it has increasingly become an ever more heterogeneous assemblage of species.

In this connection it must be said again that although the taxonomy of many anamorphs may not always accurately reflect phylogeny, form-genera should not be allowed to become so artificial and unnatural as to defy reason and thereby compromise their usefulness and validity. During the course of the last several decades, as Gams (1995) has astutely noted, with reference to anamorph genera, an increased effort has been expended to delineate more natural entities. With this in mind it would appear that a review of the present circumscription of *Acrodictys* is more than timely. In this genus, it is abundantly apparent that a number of what should be regarded as phylogenetically informative characteristics have not been adequately focused upon and utilized taxonomically, nor has its delimitation been sufficiently rigorous and critical.

The recent collection in Alabama of an interesting dictyosporous, dematiaceous anamorph with annellidic, percurrently proliferating conidiophores, morphologically broadly similar to some species presently classified in *Acrodictys*, has further stimulated a reconsideration of the circumscription of the genus as originally conceived and established by Ellis (1961). This entity, which we believe to represent a novel taxon, was encountered on decaying, decorticated wood. Within the now traditional boundaries of *Acrodictys*, it could, perhaps, be satisfactorily classified in this genus but critical consideration of its salient characteristics has led us to the conclusion that it differs sufficiently from the type species, *A. bambusicola* M.B. Ellis, to merit and warrant accommodation in a separate genus. By the same token, several species currently assigned to *Acrodictys*, have essential features in common with the newly-discovered anamorph, and can be considered congeneric with it. We believe these taxa to be misplaced in *Acrodictys*.

The morphological differences present among species currently classified in *Acrodictys*, in the broad sense in which it is presently defined, include divergent patterns of conidium septation and coloration, presence or absence of conidial appendages, varying conidiophore appearance, depending upon occurrence or non-occurrence of percurrent growth related to conidiation, and the precise nature of the proliferation in terms of origin and shape. In the type species, *A. bambusicola*, and certain others such as *A. atroapicula* Wang & B. Sutton, *A. elaeidicola* M.B. Ellis, and *A. similis* Hol.-

Jech., conidial septation is classically muriform, with primary transverse septa being initially laid down, followed by the development of longitudinal or oblique septa. In these species, the conidia are distinctly pyriform in shape and there is a distinct gradation in pigmentation density from a paler basal portion to an appreciably darker apex. The conidiophores of these species proliferate percurrently in a manner that has been described as being through a scar left following secession of a preceding conidium (Ellis, 1961; Wang and Sutton, 1982), giving rise to one or more distinctly lageniform or doliiform extensions. Interestingly, Minter and Holubová-Jechová (1981) referred to similar proliferations in *Sporidesmium doliiforme* Minter & Hol.-Jech. [now *Penzigomyces doliiforme* (Minter & Hol.-Jech.) Subram.] as occurring through the conidiogenous cell septal pore while Hernández-Gutiérrez and Sutton (1997) described identical proliferations in *Imimyces* A. Hern. & B. Sutton as originating enteroblastically. In *A. bambusicola*, such proliferation appears to occur relatively infrequently and, usually, only once per conidiophore. In *A. atroapicula*, in contrast, most conidiophores exhibit this secondary growth pattern with up to three proliferations, whereas in *A. elaeidicola* up to ten or more may be present. It should be noted that similarly-shaped terminal proliferations are also characteristic of such genera as *Brachysporiella* Bat., *Imimyces* and *Penzigomyces* Subram. The latter two are segregates from *Sporidesmium* Link, *sensu lato*, in part characterized by possession of this feature. Another aspect of this type of proliferation is a tendency for a small area above and below the juncture of each unit to become densely pigmented, giving a banded effect.

Within *Acrodictys*, as presently circumscribed, several other clusters of taxa with characteristics differing significantly from those described above, can be recognized. In addition, there exist a number of other entities that seemingly appear to be so individually unique as not to fit into any obvious group. Some of these nonconforming taxa have been removed and classified elsewhere, while others still remain in *Acrodictys*. A group of taxa, to which the novel Alabama collection belongs, can be recognized by the following characteristics. The conidia of these species are more or less subglobose to globose in shape and bear a prominent, protruding, basal cell, are uniformly pigmented, and cell division thereof is irregular, in the sense that compartmentalization comes about by the laying down of a series of largely angular or oblique septa, in what appears to be a random fashion. The conidiophores of these species flare slightly toward the apex, making this generally wider than the middle portion, and they proliferate percurrently in the manner of the classic annellide, as well exemplified in such genera as *Acrodictyella* W.A. Baker & Partridge, *Annellophora* S. Hughes, *Camposporidium* Nawawi & Kuthub., and *Repetophragma* Subram. Each successive conidium originates by meristematic growth of a broad half-septum, derived following the schizolytic split in the septum originally delimiting the preceding spore. Each such proliferation maintains a more or less cylindrical shape or may be somewhat cuneiform or axe-blade shaped with the upper limit broader than at the level of origin and sometimes very slightly flared. These peculiarities contrast sharply with the condition seen in *Acrodictys* in a strict sense.

A third cluster of species within *Acrodictys* is recognized by possession of determinate, non-proliferating or indeterminate, proliferating conidiophores and very large, dictyosporous, numerous-celled, more or less evenly dark-colored, somewhat irregularly-shaped conidia in which all septa are orientated obliquely. The conidia of some such taxa bear appendages originating from outer, peripheral cells. Among the entities having these characteristics are *A. appendiculata* M.B. Ellis, *A. brevicornuta* M.B. Ellis, *A. deightonii* M.B. Ellis, *A. dennisii* M.B. Ellis, and *A. eickerii* Morgan-Jones. Where proliferations occur among these, especially in *A. brevicornuta, A. deightonii*, and *A. eickerii*, they are broadly similar in form to those present in *Acrodictys* in the narrower sense; that is, they are more or less lageniform to doliiform in shape.

Among the species which can be considered highly atypical of the genus and outside the three main groups mentioned and discussed above are such entities as *A. elaeidis* J.M. Yen & Sulmont, *A. kamatii* Narendra & V.G. Rao, *A. malabarica* Subram. & Bhat, *A. queenslandica* Matsush., *A. stilboidea* J. Mena & Mercado, and *A. viridescens* B. Sutton & Alcorn. The taxonomic status of these clearly requires reconsideration and it seems likely that redisposition will be found to be necessary. In this connection it should be noted that some taxa have already been transferred; *Acrodictys elaeidis* was removed by Pirozynski (1972) to the genus *Septosporium* Corda [as *S. elaeidis* (J.M. Yen & Sulmont) Piroz.] but Holubová-Jechová (1983) maintained this species in *Acrodictys* when she described *A. elaeidis* var. *cubensis* Hol.-Jech. It seems unlikely that it should remain in *Acrodictys*. *Acrodictys excentrica* B. Sutton is another species originally classified in *Acrodictys* but which has subsequently been transferred. Hughes (1979) placed it in *Arachnophora* Hennebert, as *A. excentrica* (B. Sutton) S. Hughes, on account of its having excentric conidia and rhexolytic conidial detachment. Castañeda and Kendrick (1990), however, made it the second species of their new genus *Digitoramispora* Castañeda & W.B. Kendr. [as *D. excentrica* (B. Sutton) R.F. Castañeda & W.B. Kendr.]. In their publication, surprisingly, the latter authors made no reference whatsoever to the recombination made by Hughes (loc. cit.) eleven years earlier. In the description of *D. caribensis* Castañeda & W.B. Kendr., the type species of *Digitoramispora*, no mention is made either of the method of conidial secession but judging from the apparent absence of a basal frill and the fact that the conidiophores are typical annellides it seems likely that this occurs schizolytically by the splitting of a delimiting septum. If this is the case, *A. excentrica* may very well be misplaced in *Digitoramispora.* Two other species, namely *A. corniculata* Castañeda and *A. triarmatus* Whitton, McKenzie & K.D. Hyde, have characteristics in common with *A. excentrica* and in any critical revision of the taxonomy of atypical *Acrodictys* taxa, consideration should be given to this fact. No account of the peculiarities of conidium disarticulation was given in the original descriptions of either of these species (Castañeda, 1985; Whitton *et al.,* 2000) although the base of the conidia of *A. triarmatus* was said to be "often with a conical and protuberant portion of the conidiogenous cell attached".

Other anomalous or doubtful *Acrodictys* taxa include *A. fimicola* M.B. Ellis & Gunnell and *A. sacchari* M.B. Ellis, two species which are undoubtedly closely related, and *A. brooksiae* M.B. Ellis, which grows on conidiophores of *Hiospira hendrickxii* (Hansf.) R.T. Moore. None of these fit into a *sensu stricto* concept of *Acrodictys* and their reclassification seems desirable. In the case of *A. brooksiae*, Deighton and Pirozynski (1966) proffered the opinion that the structures referred as conidia of this species are probably aborted ascomata or ascomatal primordia of *Brooksia tropicalis* Hansf. [Dothideales].

Acrodictys fuliginosa B. Sutton was transferred by Hughes (loc. cit.) to *Endophragmiella* B. Sutton [as *E. fuliginosa* (B. Sutton) S. Hughes] because of rhexolytic conidial detachment, despite having conidia that are closely similar to those of *Acrodictys,* except for bearing a marginal frill at their base. A position was taken that, in this complex, the method of conidium detachment and the origin of proliferations should take precedence over conidium morphology and septation. Thusly, the mode of conidial disarticulation was considered to be, phylogenetically, the more informative. Since the conidia of *E. fuliginosa* are strikingly different from those of *E. pallescens* B. Sutton, the type species of *Endophragmiella,* in both septation and pigmentation, the alternative option of classifying this taxon in a novel genus may, however, in future, deserve reconsideration. In this context, the absence of any conidiophore proliferation in *E. fuliginosa* is an additional feature that should be noted. Two other species, namely *A. erecta* (Ellis & Everh.) M.B. Ellis [of which *Acrodictys satwalekeri* D. Rao (Rao, 1970) is undoubtedly a synonym] and *A. dennisii* M.B. Ellis, share some similarities with *A. fuliginosa* and might be candidates for inclusion with it in a separate genus. Preliminary studies (Baker and Morgan-Jones, unpublished data) clearly indicate rhexolytic conidium secession in *A. erecta*, which gives weight to the view that it, too, is unsatisfactorily classified in *Acrodictys*.

With the aim of contributing toward resolution of some of the problems presently existing with the circumscription of *Acrodictys* and to bring about a more refined delineation, the type description of the genus is herein amplified and emended in order to particularize in more detail its salient hallmark characteristics, as exemplified by *A. bambusicola* and similar species. In accordance with the dictates of Article 47 of the ICBN this emended description which, in effect, amounts to an alteration of the stipulated diagnostic characters, and thereby the circumscription of the genus, is not formalized with citation of the name of an author since the type species is not excluded. To complement this, the type and two other species, one of which, *A. atroapicula*, has recently been collected by one of us in North Carolina, are redescribed and illustrated. These three species, collectively, well exemplify a *sensu stricto* generic concept and the range of morphological variation within it upon which species differentiation is based.

A new generic name is established to accommodate those species considered to belong to the second cluster of taxa discussed above, including the novel entity. Included are the anamorphs presently known as *A. globulosa* (Tóth) M.B. Ellis, *A. lamma* Whitton, McKenzie & K.D. Hyde, *A. martinii* Crane & Dumont, and *A. obliqua* M.B. Ellis. Some others, such as *A. peruamazonensis* Matsush., and *A. septosporioides* Matsush., may also, conceivably, belong here but a decision concerning this must remain pending, until such time as their type specimens are examined. Two of the taxa, namely *A. lamma* and *A. martinii*, are being reclassified herein on the basis of the information provided in their original descriptions and illustrations (Whitton *et al.,* loc. cit.; Crane and Dumont, 1975; respectively), for there can be no doubt as to the fact that they are congeneric with the type species of the new genus. As has been the case in the genus *Sporidesmium* [see Subramanian, 1992; McKenzie, 1995; Hernández-Gutiérrez and Sutton, loc. cit.], we believe the segregation of morphologically divergent genera to be both desirable and defensible. Other species that probably belong elsewhere, including some of those listed as outlying, discordant, deviating nonconformers, will form the subject of a later publication, dependent upon type material being made available for examination. The appropriate fate for those taxa referred to the third group remains uncertain at this time and requires further consideration.

TAXONOMIC PART

Acrodictys M.B. Ellis, *Mycol. Pap.* 79:5, 1961.

Colonies effuse, hairy, olivaceous brown to dark, blackish-brown. Mycelium partly superficial but mostly immersed in the substrate, composed of branched, septate, smooth, pale brown hyphae. Conidiophores macronematous, mononematous, single and scattered or gregarious and loosely caespitose, originating laterally from the hyphae or from swollen, more or less subglobose, thick-walled, brown cells, simple, erect, straight or, more often, somewhat flexuous, smooth, cylindrical but attenuating gradually toward the upper limits, frequently bulbous at the base, septate, brown, determinate and non-proliferating or, more commonly, indeterminate and proliferating percurrently; successive terminal proliferations lageniform to doliiform in shape, originating apically at a narrow, unevenly-thickened half-septum at the juncture where a preceding conidium was delimited. Conidiogenous cells integrated, terminal, monoblastic. Conidia holoblastic, solitary, dry, acrogenous, obovoid to pyriform, muriform, usually with vertical-longitudinal septa in the middle cells and mostly oblique septa subdividing the upper portion, mid to dark blackish-brown, often with a gradation from lighter in the lower extremity to darker toward the apex, smooth, narrowly truncate at the base, occasionally with a seceded conidiogenous cell remaining attached.

Type species: *Acrodictys bambusicola* M.B. Ellis.

Acrodictys atroapicula C.J.K. Wang & B. Sutton, *Mycologia* 74:492, 1982 (Figure 1).

Colonies effuse, hairy, blackish-brown to black, often spreading widely and densely. Mycelium partly superficial but mostly immersed in the substrate, composed of branched, septate, smooth, pale to mid-brown, 3-5μm wide hyphae, which give rise to small clusters of subglobose, thick-walled, 6-8μm wide brown cells from which conidiophores originate. Conidiophores macronematous, mononematous, solitary or, more often, in groups of two to four formed from adjacent swollen cells, simple, erect or ascending, straight or frequently somewhat flexuous, smooth, cylindrical but attenuating appreciably and gradually from a broad, 6-10μm wide basal portion, to a narrower, 3-5μm wide apex, often slightly bulbous at the extreme base, up to 100μm long, septate, with septa laid down at more or less regular, short intervals along the length, usually 7-11μm apart, brown to dark brown, paler distally, indeterminate, with one or more successive, terminal, percurrent proliferations. Conidiogenous cells integrated, apical, monoblastic, lageniform to doliiform in shape; the first originating as the terminal conidiophore cell with subsequent ones arising following schizolytic disarticulating of each successive conidium at a narrow, unevenly-thickened, delimiting septum. Conidia holoblastic, solitary, dry, acrogenous, obovoid to pyriform, muriform, usually with three to five transverse septa and several longitudinal or oblique septa, the latter mainly subdividing the upper portion, mid-brown in the lower half, dark blackish-brown in the upper portion, often with a somewhat abrupt transition between the differing pigmentation intensities, smooth, narrowly truncate at the 3-4μm base, 16-25 × 11-13μm in size; sometimes with a seceded conidiogenous cell remaining attached.

On decaying, decorticated hardwood; North America.

Collection examined: on rotten wood, Bent Creek Research and Demonstration Forest, Buncombe County, North Carolina, U.S.A., 3 September 2000, W.A. Baker, AUA.

Acrodictys atroapicula was originally described from several collections made on rotten wood in New York and Massachusetts (Wang and Sutton, loc. cit.). The specimen obtained in North Carolina agrees in all essential details with the type description, although the conidia are very slightly narrower. This taxon, as noted by its authorities, is morphologically quite similar to *A. elaeidicola* but the two are readily distinguishable by several features. In *A. atroapicula* the conidiophore may bear up to three percurrent proliferations, whereas in *A. elaeidicola* there may be up to ten or more successive conidiogenous cells formed. The conidiophores of the two species are also different in that those of *A. atroapicula* are shorter, with a greater width differential between base and apex, are more closely septate, and the periclinal wall, particularly in the lower portion, is narrower. The conidia of *A. atroapicula* are less constricted at the junctures of the septa and the outer wall, and are subdivided into a greater number of cells. Moreover, the upper half of the conidia of this entity are appreciably darker than is the case in *A. elaeidicola*.

Acrodictys bambusicola M.B. Ellis, *Mycol. Pap.* 79:6, 1961 (Figure 2).

Colonies effuse, dense, hairy, blackish-brown to black. Mycelium partly superficial but mostly immersed in the substrate, composed of branched, septate, smooth, pale brown to brown, 2-4μm wide hyphae. Conidiophores macronematous, mononematous, solitary, arising laterally from vegetative hyphae, erect, straight or slightly flexuous, smooth,

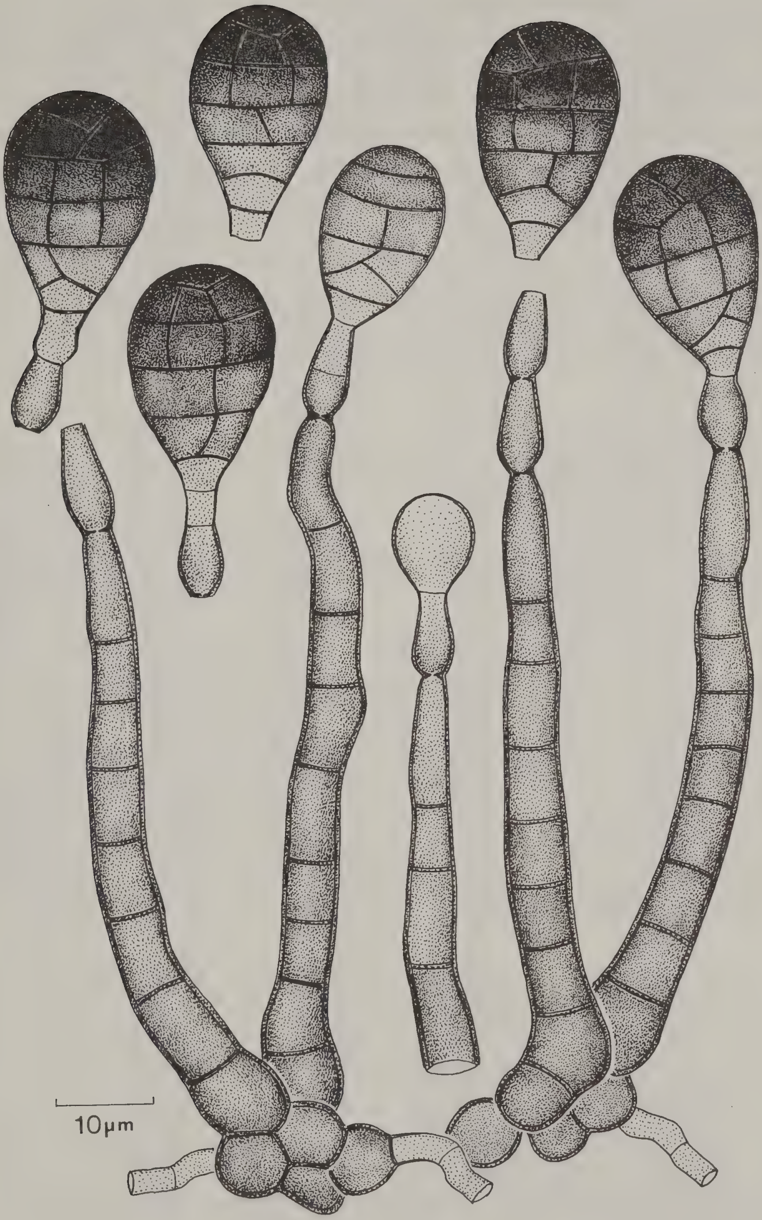

FIGURE 1. *Acrodictys atroapicula*. Conidiophores and conidia.

cylindrical but attenuating gradually from a 5-7μm wide basal portion to a 2-5μm wide apex, occasionally somewhat bulbous at the base, up to 280μm long, septate, brown to dark brown, paler distally, determinate and non-proliferating or, less often, indeterminate, with usually one terminal, percurrent proliferation; occasionally with percurrent, regenerative growth. Conidiogenous cells integrated, terminal, monoblastic, cylindrical but attenuating distally, lageniform in shape where originating from a percurrent proliferation. Conidia holoblastic, solitary, dry, acrogenous, obovoid to pyriform, muriform, usually with two to five transverse septa and several longitudinal or oblique septa, somewhat constricted at the septa, pale brown to brown with a gradual gradation from a lighter base to a darker upper portion, smooth, narrowly truncate at the 2-4μm wide base, 17-30 × 14-18 μm in size.

On decaying culms of *Bambusa* Schreb. and *Pennisetum purpureum* Schumach.; tropics and subtropics.

Collection examined: on bamboo, El Avila & Avila-Vaiguata, Venezuela, 4 July 1958, R.W.G. Dennis, IMI 74733, holotype.

Acrodictys bambusicola appears to be plurivorous and widely distributed in tropical and subtropical regions world-wide. It has been collected on *P. purpureum* [elephant grass] in Uganda (Ellis, 1961), on *Bambusa multiplex* (Lour.) Raeusch. in Okinawa, Japan (Matsushima, 1975), and there are records of it on unnamed species of *Bambusa* in Cuba (Holubová-Jechová and Mercado, 1984, 1986; Mercado and Mena, 1986). Matsushima (1980) reported its occurrence on stems of a *Phyllostachys* sp. in Taiwan and the same author (Matsushima, 1993) collected it on decaying petioles of an unidentified palm in Peru.

As is the case in *A. atroapicula*, a conidiogenous cell derived from a percurrent proliferation may remain attached to the base of a conidium at the time of secession in *A. bambusicola*, although this characteristic does not appear to occur as commonly in the latter. This may reflect the fact that percurrent proliferation appears to be restricted in *A. bambusicola* with conidiophores being either non-proliferating or doing so only once in relation to conidiation. This contrasts sharply with the condition seen in *A. elaeidicola* [see below] where a linear plurality of conidiogenous cells is formed on a single conidiophore. In its type description, Ellis (1961) noted that the conidiophores of *A. bambusicola* have up to five terminal proliferations but in his illustration what appears to be regenerative growth, presumably unrelated directly to conidium production, is featured. Such conidiophore

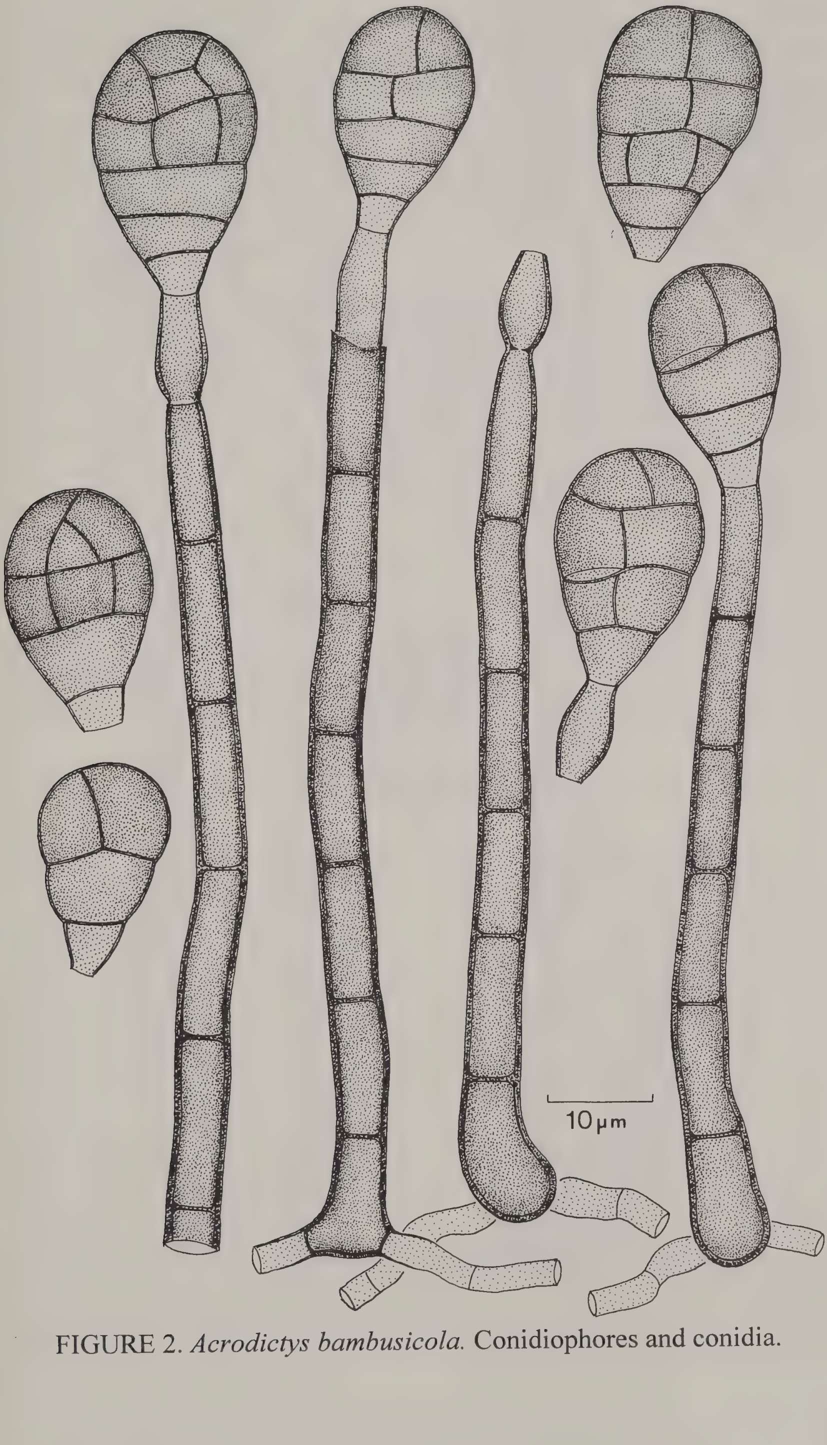

FIGURE 2. *Acrodictys bambusicola.* Conidiophores and conidia.

extension can be readily recognized by an irregular, uneven tear in the periclinal wall of the mother cell at the point of renewed meristematic activity. This type of somatic vegetative proliferation can, moreover, be distinguished from that associated with serial conidiation by the fact that a cylindrical shape is maintained in contrast to the distinctly lageniform aspect of a conidiogenous cell. In addition, it should be noted that this form of conidiophore growth is characterized by the extended portion having an appreciably thinner wall and being much less pigmented.

What was referred to as a *Selenosporella* synanamorph of *Acrodictys bambusicola* was encountered by Matsushima (1975) in axenic *in vitro* culture. In terms of conidiophore morphology and conidial size, however, this bears some resemblance to taxa placed in *Idriella* P.E. Nelson & S. Wilh., [see Morgan-Jones (1979)]. The anamorph named *I. bambusae* Morgan-Jones bears a striking resemblance to the synanamorph described by Matsushima and could well be the same entity. When applying the generic names *Idriella* and *Selenosporella* to synanamorphs, it is important to distinguish between the respective polyphialidic and polyblastic nature of their conidiogenous cells. Lack of discrimination in this regard can lead to confusion. Matsushima (1987) described an *Idriella* synanamorph for *Sporidesmium tropicale* M.B. Ellis but Réblová (1999) referred to this as a *Selenosporella* synanamorph, even though the existence of a polyblastic conidiogenous cell is specified.

Acrodictys elaeidicola M.B. Ellis, *Mycol. Pap.* 79:7, 1961 (Figure 3).

Colonies effuse, hairy, black. Mycelium partly superficial but mostly immersed in the substrate, composed of branched, septate, smooth, pale to mid-brown, 2-4μm wide hyphae. Conidiophores macronematous, mononematous, solitary or, occasionally, in groups of two to three formed laterally from hyphae, simple, erect or ascending, straight or frequently somewhat flexuous, smooth, cylindrical but attenuating gradually from a broad 4-8μm wide basal portion to a narrower, 3-4μm wide apex, usually slightly bulbous at the base, up to 180μm long, septate, dark brown to blackish-brown, paler distally, very thick-walled, indeterminate, with up to eleven successive terminal percurrent proliferations. Conidiogenous cells integrated, terminal, monoblastic, lageniform to doliiform in shape, with those in a distal position becoming progressively shorter and distinctly barrel-shape; clusters of conidiogenous cells occasionally disarticulating from the main conidiophore stipe. Conidia holoblastic, solitary, dry, acrogenous, obovoid to pyriform, muriform, usually with three transverse septa and several longitudinal or oblique septa, the latter mainly subdividing the upper

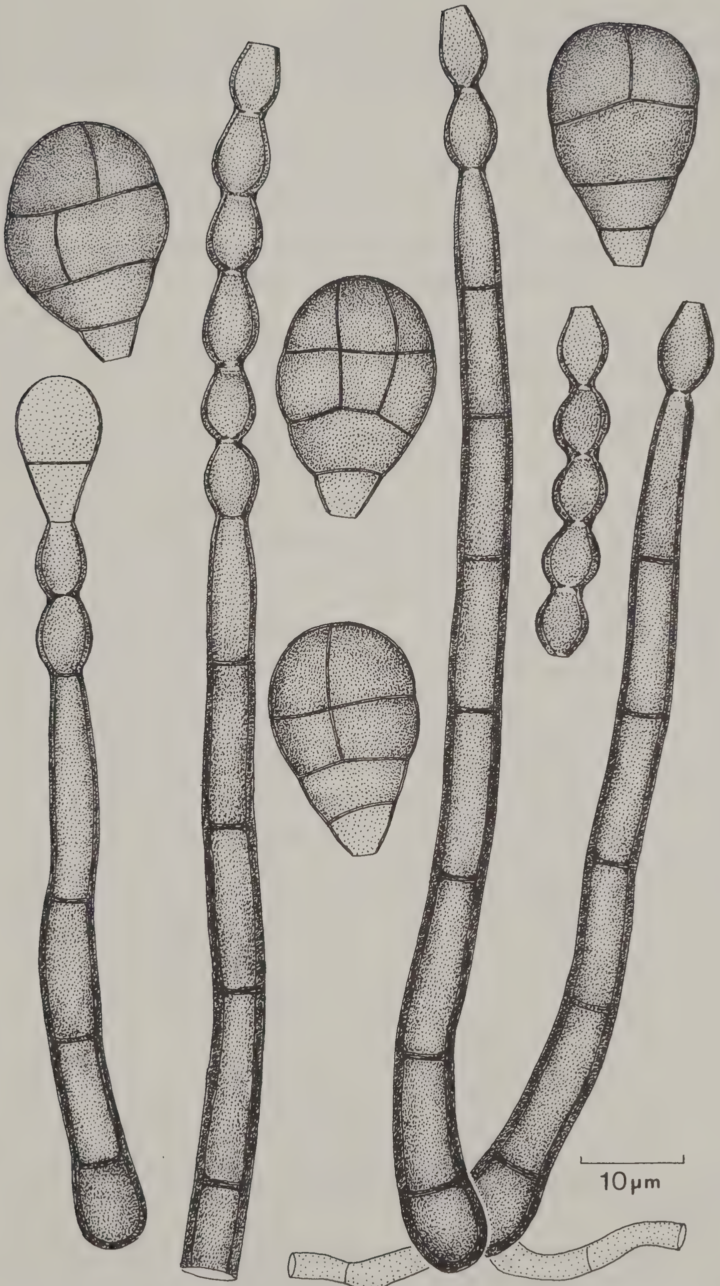

FIGURE 3. *Acrodictys elaeidicola*. Conidiophores and conidia.

portion, with the lower two cells remaining undivided, somewhat constricted at the septa, pale to mid-brown in the lower half, brown to dark brown above, smooth, narrowly truncate at the 2-3μm wide at the base, 20-26 x 14-18μm in size.

On dead rachides of *Elaeis guineensis* A. Cheval.; Africa.

Collection examined: on *E. guineensis* [oil palm], Hohoe, Ghana, 28 May 1949, S.J. Hughes, IMI 38636, holotype.

In addition to the type specimen, a number of collections of this species were made in the early 1950s by Mr. F.C. Deighton in Sierra Leone on the same host. Matsushima (1993) reports a collection of *A. elaeidicola* on decaying petioles of an unnamed palm from Rio Negro, Peru. However, some doubt must remain as to the correct identity of this material since the conidia, while of a broadly similar length, are appreciably narrower than is typical of this taxon, giving a very different length/width ratio. *Acrodictys similis*, which was described from dead branches of *Bambusa* in Cuba, as noted by Holubová-Jechová and Mercado (1984), closely resembles *A. elaeidicola*. Its conidia are of a similar width to those of the Matsushima collection and it seems possible that the Peru specimen represents this species rather than *A. elaeidicola*. Holubová-Jechová and Mercado (1984) and Matsushima (1993) provide inadequate or no documentation of percurrent proliferation in their respective collections, which makes a detailed comparison with *A. elaeidicola* difficult on the basis of the information available. Interestingly, Matsushima (1993) stated that *A. similis* is close to *A. bambusicola* which is, perhaps, indicative of the fact there exists a need for revisiting and critically reviewing the question of species distinctiveness and for more detailed characterization of the taxa involved. It certainly seems conceivable that the morphological discontinuities are so subtle as to make accurate identification problematic. Other records of *A. elaeidicola* include those made on oil palm in Tanzania by Pirozynski (loc. cit.), on dead rachides of an unidentified palm in Veracruz, Mexico, by Heredia *et al.* (1997), and on decaying leaves of *Pandanus* sp. in Brunei by Whitton *et al.* (loc. cit.). [Note: Whitton *et al.*(loc. cit.) erroneously list collections on *Roystonea regia* (H.B.K.) O.F. Cook in Cuba (Mercado, 1984) and on *Elaeis guineensis* in Gabon (Ellis, 1976) as being of *A. elaeidicola*. These records were of *A. elaeidis*.]

The peculiarities of percurrent proliferation in *A. elaeidicola*, in terms of both the extent of its occurrence and the morphology of each conidiogenous unit, appear to be unique among species of *Acrodictys*. The successively-produced, short, barrel-shaped conidiogenous cells are particularly distinctive, giving the conidiophores a striking appearance. Moreover, the phenomenon of the disarticulating of a linear group of such cells is an added feature which should serve to further distinguish this taxon.

Another aspect of the morphology of members of *Acrodictys sensu stricto* which helps define the individual taxa is the extent of conidial septation. In the case of *A. elaeidicola*, the conidia have fewer secondary longitudinal and oblique septa than is typical of some of the other species, including *A. bambusicola*. Many conidia of *A. elaeidicola* are, in fact, divided by only one or two longitudinal septa. In this regard, it is similar to *A. balladynae*, a species which, as noted above, has non-proliferating conidiophores.

Junewangia W.A. Baker et Morgan-Jones, gen. nov.

Coloniae effusae, velutinae vel interdum pilosae, pallide brunneae ad atrobrunneae, plerumque sparsae. Mycelium superficiale vel maximum partim immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, cylindricis compositum. Conidiophora macronemata, mononemata, singula vel 2-3 caespitosa, ex lateribus hypharum vel cellulis inflatis oriunda, erecta vel ascendentia, recta vel flexuosa, laevia, parietibus crassis, cylindrica, saepe basi inflata, continua vel septata, brunnea, sursum pallidiora, indeterminata, plerumque ad proliferationes percurrentes successivas elongascienta. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, pallide brunnae, anguste cuneatae, apicem versus truncatum. Conidia holoblastica, solitaria, sicca, acrogena, ovalia vel sub sphaeroidea vel sphaeroidea, septis numerosis obliquus predita, pallide brunnea vel brunnea vel atrobrunnea, aequaliter pigmentifera, laevia, ad basim truncata, secessio schizolytica.

Species typica: *Junewangia sphaerospora* W.A. Baker et Morgan-Jones.

Junewangia W.A. Baker & Morgan-Jones gen. nov.

Colonies effuse, velvety or somewhat hairy, pale brown to blackish brown, often rather sparse and thin. Mycelium partly superficial or, more often, predominantly immersed in the substrate, composed of branched, septate, pale brown to brown, smooth, cylindrical hyphae. Conidiophores macronematous, mononematous, single or in small clusters of two or three, arising laterally from the hyphae or from thick-walled, inflated, subglobose hyphal cells, erect or ascending, straight or slightly flexuous, smooth, thick-walled, cylindrical often swollen at the base, sometimes with the distal end flaring slightly to become wider than the middle portion, continuous or septate, brown, often paler distally, indeterminate, elongating by successive percurrent proliferations. Conidiogenous cells integrated, terminal, monoblastic, pale brown, cylindrical or often narrowly cuneate in shape, truncate at the apex. Conidia holoblastic, solitary, dry, acrogenous, oval to subspherical to almost spherical, with numerous oblique septa, pale brown to brown to blackish brown, more or less evenly pigmented, smooth, with a protuberant, truncate basal cell, seceding schizolytically.

Etymology: this genus is named in honor of Dr. C.J.K. Wang, State University of New York, Syracuse, in recognition of her contributions to knowledge of dematiaceous Hyphomycetes.

Junewangia globulosa (Tóth) W.A. Baker & Morgan-Jones comb. nov. (Figure 4).

≡ *Monodictys globulosa* Tóth, *Ann. hist.-nat. Mus. hung.* 54:183, 1962.

≡ *Acrodictys globulosa* (Tóth) M.B. Ellis, *Mycol. Pap.* 103:34, 1965.

Colonies effuse, hairy, brownish, usually rather sparse. Mycelium partly superficial to mostly immersed, composed of branched, septate, smooth, pale to mid brown, 2-4μm wide hyphae. Conidiophores macronematous, mononematous, single or in small clusters of two or three, originating as lateral branches or, more frequently, arising from thick-walled, inflated, more or less subglobose, 5-6.5μm wide hyphal cells, erect or ascending, straight or somewhat flexuous, sometimes with a slight bend toward the middle, smooth, thick-walled, cylindrical, often narrowly bulbous at the base, slightly wider at the apex than in the middle portion, septate, mid brown, paler distally, indeterminate, elongating by successive percurrent proliferations, of which there maybe up to two or three, up to 70μm long, 5-6μm wide, 6-7.5μm wide at the base. Conidiogenous cells integrated, terminal, monoblastic, pale brown, widely truncate at the apex following conidium disarticulating. Conidia holoblastic, solitary, dry, acrogenous, subglobose, with variously orientated septa from initially transverse to longitudinal to predominantly oblique when mature, pale to cinnamon brown, evenly pigmented, smooth, thick-walled, with a distinctly protuberant, broadly cuneate, truncate basal cell, seceding schizolytically, 22-30 × 20-25μm in size, 5-6μm wide at the base.

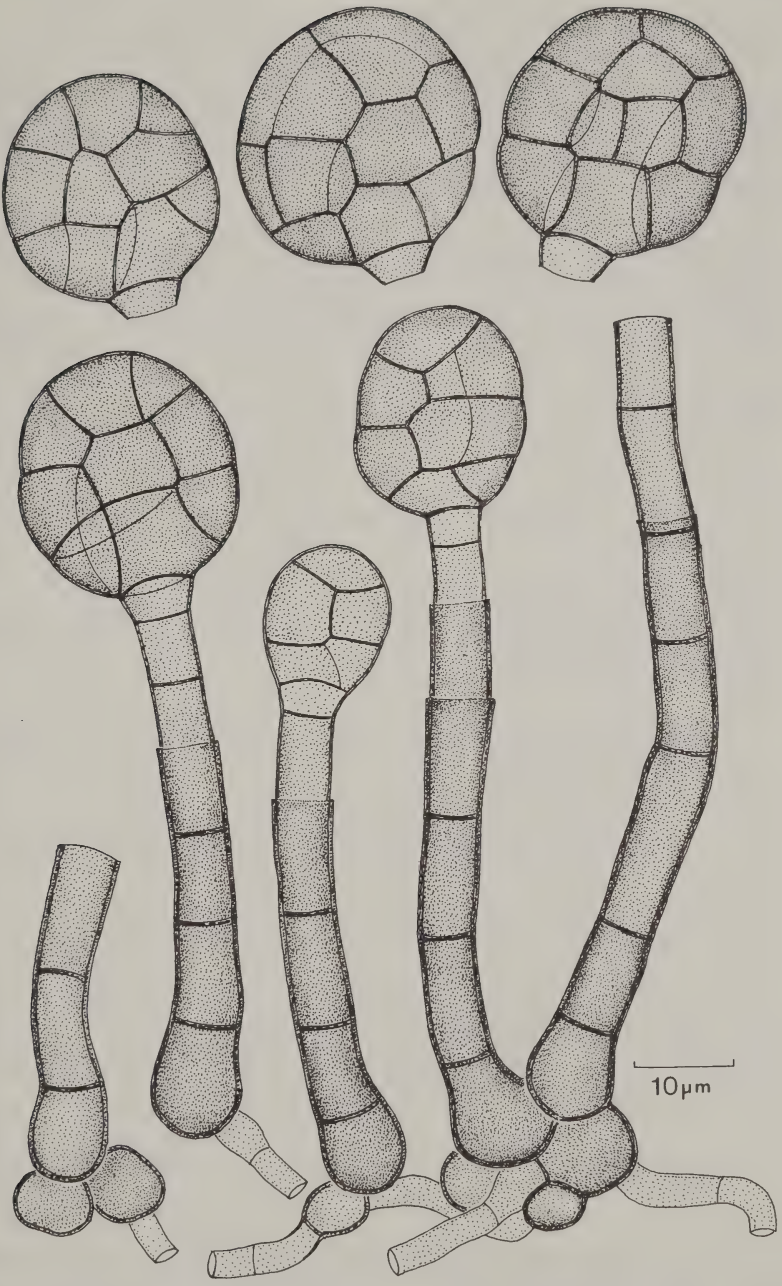

FIGURE 4. *Junewangia globulosa*. Conidiophores and conidia.

Plurivorous; cosmopolitan.

Collections examined: on dead stems of *Clematis vitalba* L., Dédesvár, Bukk hegység, Hungary, 16 August 1960, S. Tóth, IMI 101012 [slide ex BP], holotype; on bark of unidentified tree, Gberia, Fotombus, Sierra Leone, 19 August 1963, P.W. Sellar, IMI 103373c.

Junewangia globulosa appears to have a widespread distribution on a variety of substrates. It has been collected on rotten stem of *Musa* × *paradisiaca* L., in the Solomon Islands (Matsushima, 1971), on decaying petiole of *Arenga engleri* Becc. in Okinawa, Japan (Matsushima, 1975), on leaves of *Daemonorops margaritae* (Hance) Becc., and on *Semecarpus gigantifolia* Vidal, in Taiwan (Matsushima, 1980), on rotten bamboo stems and dead seed pods of *Leucaena leucocephala* (Lam.) de Wit [as *Leucaena glauca* (L.) Benth.] in Yap, the Caroline Islands, and Guam, respectively (Matsushima, 1983), and on decaying palm petioles in Peru (Matsushima, 1993). There are also records of it on bark of *Alnus* sp. and *Populus tremuloides* Michx., in Manitoba, Canada (Sutton, 1973), on dead wood in Belize (Morris, 1978), and on dead branches of a number of other hosts in Cuba and Mexico (Mercado, 1982; Mercado and Mena, 1986; Mena and Mercado, 1987; and Heredia *et al.*, loc. cit.)

Junewangia lamma (Whitton, McKenzie & K.D. Hyde) W.A. Baker & Morgan-Jones comb. nov.

≡ *Acrodictys lamma* Whitton, McKenzie & K.D. Hyde, *Fungal Diversity* 4:163, 2000.

[For description and illustration see Whitton *et al.* (loc. cit.)]

In all essential characteristics, this taxon fits comfortably in *Junewangia*. The morphology of its conidiophores is closely similar to that of the type species. It can be readily distinguished by the smaller size of its conidia, which have fewer septa than is typical in the genus.

Junewangia martinii (Crane & Dumont) W.A. Baker & Morgan-Jones comb. nov.

≡ *Acrodictys martinii* Crane & Dumont, *Can. J. Bot.* 53:846, 1975.

[For description and illustration see Crane and Dumont (loc.cit.)]

As is the case with *J. lamma*, this species also fits comfortably in *Junewangia*, although its conidia are likewise appreciably smaller and less septate than in the type species. This taxon and *J. lamma* are, in fact, very closely similar and can be distinguished from each other only by a small difference in degree of conidial septation and in conidiophore size. The conidia of *J. martinii* are almost invariably subdivided by cruciate septation, whereas those of *J. lamma* commonly bear more septa of transverse, longitudinal, and oblique orientation. The conidiophores of *J. martinii* are, reportedly, significantly larger than those of *J. lamma* and this is thought to warrant separate recognition (Whitton *et al.,* loc. cit.), a position with which we concur.

Junewangia obliqua (M.B. Ellis) W.A. Baker & Morgan-Jones comb. nov. (Figure 5).

≡ *Acrodictys obliqua* M.B. Ellis, *Mycol. Pap.* 79:13, 1961.

Colonies effuse, hairy, brown to dark brown. Mycelium partly superficial, partly immersed in the substrate, composed of branched, septate, pale brown to brown, smooth, 2.5-4.5μm wide hyphae. Conidiophores macronematous, mononematous, single, or, more rarely, with two or three arising laterally from the hyphae in close proximity, erect or ascending, straight or slightly flexuous, smooth, thick-walled, cylindrical, often moderately swollen at the base with adjacent hyphal cells also somewhat inflated, septate, brown, paler distally, indeterminate, usually elongating once or twice by successive percurrent proliferations up to 120μm long, 5-6μm wide, 6-8μm wide at the base. Conidiogenous cells integrated, terminal, monoblastic, pale brown, truncate at the apex following conidium disarticulating. Conidia holoblastic, solitary, dry, acrogenous, usually orientated obliquely while still attached at the conidiophore apex, broadly ovoid to subspherical but somewhat irregular in shape, with numerous oblique septa, pale to mid brown, evenly pigmented, moderately thick-walled, with a distinctly protuberant, more or less short cylindric, subhyaline, truncate basal cell, seceding schizolytically, 26-35 × 19-28μm in size, 4-5μm wide at the base.

On dead wood; Africa, Asia, and Cuba.

Collection examined: on dead wood and on perithecia of *Calyculosphaeria* sp., Amanase, Ghana, 7 June 1949, S.J. Hughes, IMI 38190d, holotype.

To our knowledge, only three collections of this species have ever been made. In addition to the type specimen it was encountered on an unidentified dead branch in Cuba (Holubová-Jechová and Mercado, 1986) and on decaying leaves of *Pandanus* sp. (Whitton *et al.,* loc. cit.).

Junewangia sphaerospora W.A. Baker et Morgan-Jones sp. nov. (Figure 6).

Coloniae effusae, pilosae, pallide brunneae vel brunneae, sparsae. Mycelium superficiale vel partim immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, cylindricis, 2-4μm crassis compositum. Conidiophora macronemata, mononemata, singula, ex lateribus hypharum oriunda, erecta, recta, laevia, parietibus crassis, cylindrica, saepe basi inflata, continua vel septata, olivaceo-brunnea, indeterminata, plerumque ad proliferationes percurrentes successivas elongascienta, usque ad 65μm longa, 4-5μm crassa, ad basim 5-6μm crassa. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, pallide olivaceo-brunnea, anguste cuneatae, apicem versus truncatum. Conidia holoblastica, solitaria, sicca, acrogena, sphaeroidea ad subsphaeroidea, septis numerosis obliquus predita, olivaceo-brunnea, aequaliter pigmentifera, laevia, parietibus crassis, ad basim truncata, 15-20 × 17-20μm, secessio schizolytica.

In lignis emortuis, Chewacla State Park, Auburn, Lee Co., Alabama, USA, 13 September 2000, W.A. Baker, AUA, holotypus.

Junewangia sphaerospora W.A. Baker & Morgan-Jones sp. nov.

Colonies effuse, hairy, pale brown to brown, thin and sparse. Mycelium superficial or partly immersed, composed of branched, septate, smooth, cylindrical, pale brown, 2-4μm wide hyphae. Conidiophores macronematous, mononematous, single, arising laterally from the hyphae, erect, straight or very moderately bent, smooth, thick-walled, cylindrical but flaring slightly and somewhat wider at their extreme apices, swollen at the base, mostly continuous, rarely with a septum where occasional regenerative growth occurs, olivaceous brown, indeterminate, elongating by successive percurrent proliferations, of which there may be five or more, with each unit assuming a narrowly cuneate shape, up to 65μm long, 4-5μm wide, 5-6μm at the base. Conidiogenous cells integrated, terminal, monoblastic, pale olivaceous brown, widely truncate at the apex following conidium disarticulating. Conidia holoblastic, solitary, dry, acrogenous, spherical to subspherical, often slightly wider than tall, with numerous oblique septa, olivaceous brown, evenly pigmented, smooth, thick-walled, with a distinctly protuberant,

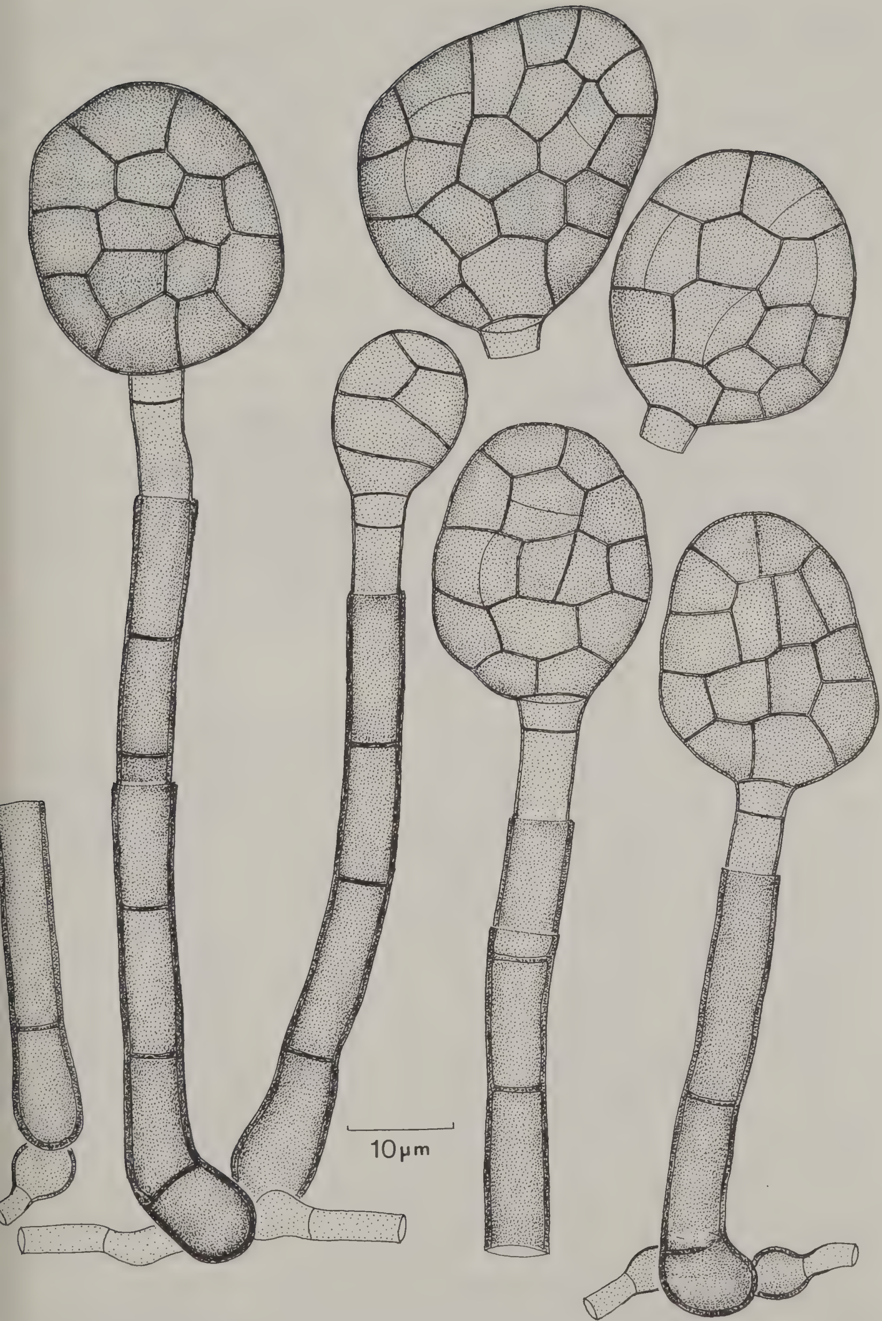

FIGURE 5. *Junewangia obliqua*. Conidiophores and conidia.

cuneate, truncate basal cell separated by a transverse septum, seceding schizolytically, 15-20 × 17-20μm in size, 4-5μm wide at the base.

On dead, decorticated wood; North America.

Collection examined: on dead wood, Chewacla State Park, Auburn, Lee Co., Alabama, USA, 13 September 2000, W.A. Baker, AUA, holotype.

Junewangia sphaerospora differs from the other two species included in the new genus in several respects. Its olivaceous coloration and the lack of conidiophore septation are particularly distinctive. In essence, the percurrently proliferated conidiophores of this species remain as continuous units, although an occasional septum may occur associated with regenerative growth. In contrast, the conidiophores of both *J. globulosa* and *J. obliqua* are invariably multiseptate along their length. Moreover, in these latter taxa the proliferated units remain more or less cylindric in shape. Other characteristics which contribute to species differentiation in this genus include relative thickness of conidial walls as well as degree of conidium septation, size, and shape.

DISCUSSION

In addition to the peculiarities which define the *sensu stricto* application of the generic name *Acrodictys*, advocated herein, several further details regarding the distinguishing features can be elaborated upon and emphasized. Although some of these may not be phylogenetically informative, or mutually exclusive, they are, nevertheless, useful in further delineating the discontinuity between the taxa which are considered appropriately classified in this genus and others which we believe to be redisposition candidates. In overall morphology the conidiophores of species included in *Acrodictys sensu stricto* are relatively uniform although it should be noted that those of some, of which *A. balladynae* (Hansf.) M.B. Ellis is an example, do not proliferate percurrently and are not as abundantly septate as is typical. The conidiophores of most of the species are attenuated distally and are subdivided by numerous transverse septa, in some cases, as in *A. atroapicula*, laid down relatively close to one another. Conidial septation is also generally uniform, with some small differences existing between species. In *A. atroapicula*, for instance, oblique or angular septations occur toward each end of the conidia, whereas in others these occur only in the upper third. The middle portion, as already mentioned, is usually, in most if not all species, compartmentalized into separate cells only by transverse and longitudinal septa. The conidial color pattern is also usefully diagnostic with

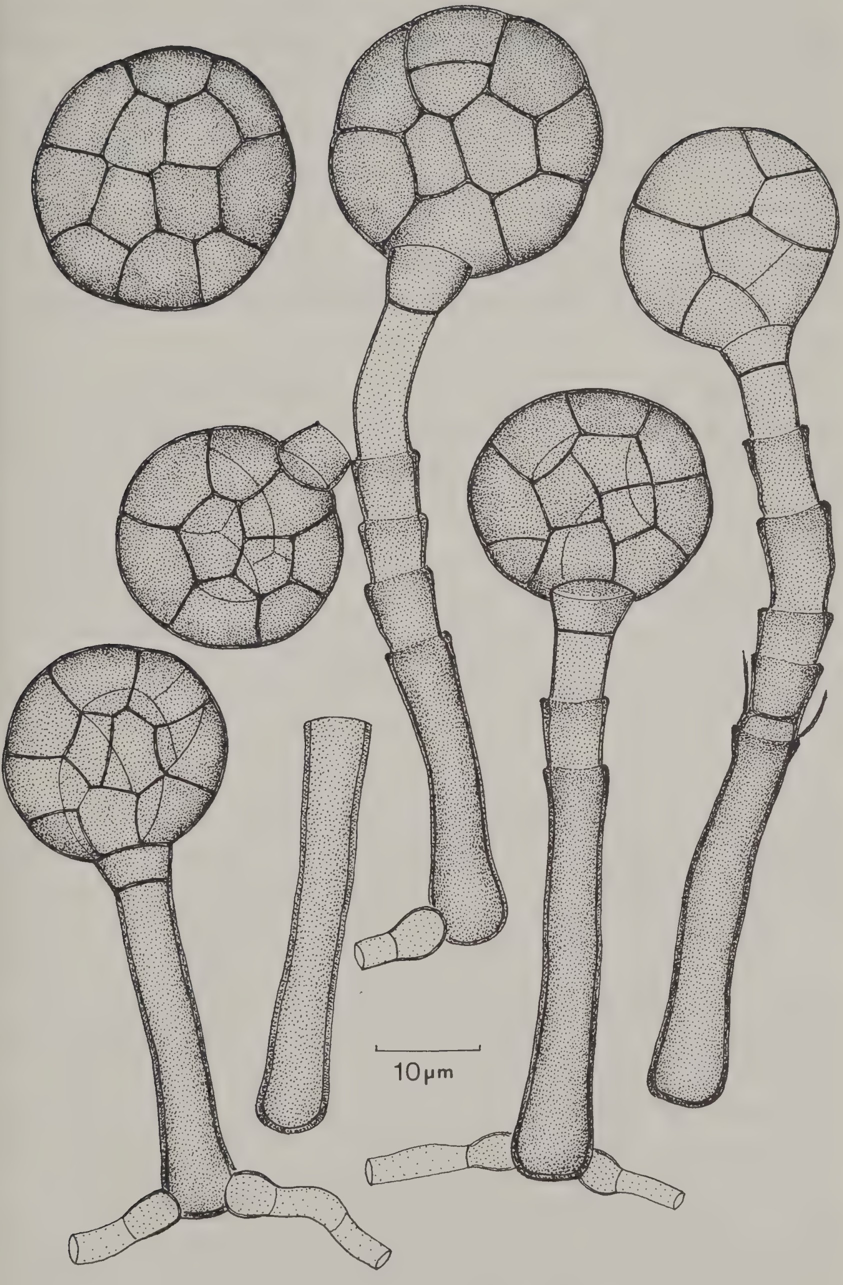

FIGURE 6. *Junewangia sphaerospora*. Conidiophores and conidia.

a gradation occurring from a densely-melanized upper portion to a much lighter base. In some species, such as *A. atroapicula*, the distal half becomes very dark and the color difference between this and the lower end may be abrupt. The phenomenon of a conidiogenous cell derived by percurrent proliferation remaining attached to a conidium at the time of secession is a peculiarity not seen in any species of *Acrodictys* other than those included in our restricted concept. For this to occur, presumably a narrow, peripheral, circumscissile zone of periclinal wall weakness must exist at the juncture between the main body of the conidiophore and a secondary conidiogenous cell, as well as between each successive unit formed by percurrent proliferation.

Interestingly, the same characteristic occurs in some other genera producing closely-similar doliiform or lageniform secondary conidiogenous units, such as *Brachysporiella*. In the type species of that genus, *B. gayana* Bat., and in *B. biseptata* W.A. Baker & Partridge, this feature is commonly seen. Some ambivalence of opinion as to the exact origin of this type of proliferation remains, however, and, in particular, the question of whether or not a half-septum, or a portion thereof, is indeed involved perhaps remains open. This uncertainty is comparable to the different interpretations of conidiogenesis in a genus such as *Paradendryphiopsis* M.B. Ellis whose conidiogenous cells, though never proliferating percurrently, look very much like those of *Acrodictys*. These were originally described (Ellis, 1976) as being monotretic but, as Hughes (loc. cit.) pointed out, the conidiogenous cell wall in this genus is entirely continuous with that of the conidium. An origin 'through' a septal pore presumably implies a *de novo* involvement of the protoplast, independently of the preexisting cell walls. Where such proliferation occurs, the narrow septum delimiting each successive conidium invariably appears unequally thickened, being appreciably thinner centrally but much thicker peripherally at the juncture with the periclinal wall. As already mentioned above, various authors have described the process involved differently. Our observations indicate that a half-septum is involved, or at least the thinner, central part thereof, since there appears to be periclinal wall continuity between each proliferated portion and each successively-formed conidium. The unequally-thickened nature of the delimiting septum can be seen as a prominent, well-developed outer rim surrounding an appreciably thinner middle portion at the center of which a pore is present. When a conidiogenous unit disarticulates from the conidiophore with a conidium remaining attached, as commonly occurs in *A. atroapicula*, a marginal thickening along its basal periphery is readily discernible. Hughes (loc. cit.), in fact, stated unequivocally that in *Acrodictys* successive proliferations are derived from the half-septa remaining following schizolytic secession. Whichever the case with regard to this peculiarity, it seems likely that the morphological expression associated with this form of secondary growth may very well be phylogenetically informative. This means, incidentally, that the *Sporidesmium* segregate genera *Imimyces* and *Penzigomyces*, whose validity, together with some others, has been questioned (Réblová, loc. cit.), and which are characterized in part by this feature, may ultimately stand up to further scrutiny.

The matter of the precise nature of percurrent conidiophore growth is obviously of critical importance in recognizing the discontinuities between the different clusters of species accommodated in *Acrodictys sensu lato*. In addition to such growth directly associated with sequential conidiation, as is noted above in some of the individual descriptions, what can best be referred to as regenerative growth, which sometimes occurs following conidiophore damage, can also occur in some of the species still maintained in *Acrodictys*, as well as in *Junewangia*. This type of conidiophore extension, which commonly occurs across a wide range of dematiaceous Hyphomycete genera with thick-walled conidiophores, should not be confused with the type of percurrent proliferation that occurs in *Junewangia* during the process of conidiogenesis. It can be readily recognized by an irregular tear in the periclinal wall that invariably accompanies its occurrence and, usually, by a substantial difference in degree of pigmentation between the mother cell and the proliferated element.

An additional complicating factor influencing any attempt to refine the taxonomy of some dematiaceous Hyphomycete form-genera lies in the presence of a *Selenosporella*-like synanamorph. In particular, its occurrence across a range of taxa raises a question as to its phylogenetic significance. It has, in recent years, become apparent that a number of possibly related genera, including *Arachnophora, Ceratosporium* Schwein., *Endophragmiella*, *Laterispora* Uecker, W.A. Ayers & P.B. Adams, *Sporidesmium*, and *Teratosperma* Syd & P. Syd., possess this characteristic [see Réblová (loc.cit.)]. A *Selenosporella*-like state is known to be formed from conidia of *Arachnophora excentrica* [≡ *Acrodictys excentrica*] (Hughes, loc.cit.) but such a synanamorph has not, to our knowledge, been reported in the type species, *A. fagicola* Hennebert. The existence of this characteristic may, incidentally, be an additional reason to doubt the suitability of classifying this taxon in *Digitoramispora*. Interestingly, anamorphs with both schizolytic and rhexolytic conidial detachment mechanisms are now known, or presumed, to have *Selenosporella*-like synanamorphs. In light of this, a reconsideration of the relative weight to be given to these respective features, when making taxonomic judgments, may be in order. The question of whether or not these characteristics are mutually exclusive remains, however, open. It should be borne in mind, as alluded to above, that accurately-made distinctions between *Idriella* and *Selenosporella* synanamorphs are critical in reaching valid decisions in this regard.

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PHYLOGENY OF AMPHISPHAERIACEAE (SENSU STRICTO) AND RELATED TAXA REVISITED BASED ON NRDNA SEQUENCES

JI-CHUAN KANG[1], RICHARD Y. C. KONG[2] AND KEVIN D. HYDE[1]

1) Centre for Research in Fungal Diversity, Department of Ecology and Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong
2) Department of Biology and Chemistry, The City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong

ABSTRACT

To further test the phylogeny of Amphisphaeriaceae (*sensu stricto*) we determined the sequence of 1742 nucleotides from the 18S nrDNA of the type species *Amphisphaeria umbrina*. The phylogenetic analyses of 18S and ITS nrDNA sequences of the present and previous studies alongside other related ascomycete GenBank retrievals revealed that the Amphisphaeriaceae (*sensu stricto*) and Xylariaceae are related and should be placed in the Xylariales. Previous conclusions that the Amphisphaeriaceae and Xylariaceae were unrelated were incorrect as DNA sequences obtained from the ITS nrDNA of *Apioclypea livistonae, Hypoxylon fragiforme, Myelosperma tumidum* and *Xylaria hypoxylon* contained ambiguities or were contaminated. These sequences are therefore withdrawn from GenBank. With this new data in mind the phylogeny of Amphisphaeriaceae (*sensu stricto*) is re-visited.

KEY WORDS: *Amphisphaeria*, Xylariales, molecular analysis.

INTRODUCTION

The ascomycete family Amphisphaeriaceae (*sensu stricto*) typified by *Amphisphaeria umbrina* has been redefined based on ITS nrDNA and morphological data, and anamorph-telemorph connections (Kang *et al.,* 1998). The family is now restricted to ten genera: *Amphisphaeria, Blogiascospora, Broomella, Discostroma, Ellurema, Griphosphaerioma, Lepteutypa, Neobroomella, Paracainiella* and *Pestalosphaeria* (Kang *et al.,* 1998). The

Broomella, *Discostroma*, *Ellurema*, *Griphosphaerioma*, *Lepteutypa*, *Neobroomella*, *Paracainiella* and *Pestalosphaeria* (Kang *et al*., 1998). The known anamorphs in all genera are coelomycetous *Pestalotia*-like taxa. The multiseptate conidia have brown central cells and hyaline end cells, with simple or branched polar appendages, and usually develop within eustromatic conidiomata (Kang *et al*., 1998, 1999a).

Eriksson (1983) proposed the provisional order Amphisphaeriales to accommodate the Amphisphaeriaceae, Cainiaceae, Clypeosphaeriaceae and Hyponectriaceae. Thereafter Eriksson and Hawksworth (1985) combined the Amphisphaerellaceae, Cainiaceae, and Clypeosphaeriaceae into the Amphisphaeriaceae (*sensu lato*), which they placed in the Amphisphaeriales that they later formally described (Hawksworth and Eriksson, 1986).

A related family, the Xylariaceae, is typified by *Xylaria hypoxylon* and incorporates similar genera which have hyphomycetous anamorphs. Based on studies of the anamorphs of *Collodiscula*, *Induratia* and *Iodosphaeria*, Eriksson and Hawksworth (1987) included the Amphisphaeriaceae in the Xylariales. Several amphisphaeriaceous genera were subsequently also transferred to the Xylariaceae. Læssøe and Spooner (1994) transferred *Collodiscula* to the Xylariaceae based on its *Acanthodochium* anamorph. *Iodosphaeria* was also excluded from the Amphisphaeriaceae (*sensu stricto*) because of its unique superficial ascomata surrounded by numerous, dark brown, septate, unbranched hairs and its synanamorphs of *Selenosporella* and *Ceratosporium* (Kang *et al*., 1999d).

A previous conclusion that the Amphisphaeriaceae (*sensu stricto*) and the Xylariaceae were from different lineages is incorrect. DNA sequences of ITS nrDNA of *Apioclypea livistonae*, *Hypoxylon fragiforme*, *Myelosperma tumidum* and *Xylaria hypoxylon* (Kang *et al*., 1998) have been found to contain ambiguities or were contaminated and therefore have been withdrawn from GenBank (Accession Numbers: AF009804, AF009809, AF009810 and AF009813). With this in mind, we determined the sequence of 1742 nucleotides from the 18S subunit of nuclear ribosomal RNA gene of *Amphisphaeria umbrina*. Using maximum parsimony, likelihood and neighbor-joining methods, the sequence data of 18S and ITS nrDNA of the present and previous studies were aligned and analyzed with the other related ascomycete GenBank retrievals to further test the phylogenetic relationship between Amphisphaeriaceae (*sensu stricto*) and Xylariaceae.

METHODS AND MATERIALS

In a previous study (Kang *et al*., 1998), fungi were cultured in liquid broth and not checked for the homology before DNA isolation which caused the contamination. Genomic DNA in the present study was isolated from fungal mycelia directly collected from the plates using the isolation protocol of Lee and Taylor (1990). Template DNA (20 ng) was amplified in a 25 µl PCR reaction mixture consisting of 10 mM KCl, 10 mM $(NH_4)_2SO_4$, 20 mM Tris-HCl (pH 8.8), 6 mM $MgSO_4$, 500 µM each of dATP, dCTP, dGTP, and dTTP, with 60 pmols NS1 and ITS4 primers (White *et al*., 1990) primers, and 1.5 units Biotaq (Bioline, London, U.K.) DNA polymerase. The reaction was set up as follows: initial denaturation at 96°C for 2 min, followed by 30 cycles of denaturation at 96°C for 15 s, annealing at 55°C for 30 s, extension at 75°C for 35 s, and final extension at 75°C for 2 min in a Rapidcycler (Idaho Technology, Idaho). A negative control using water instead of template DNA was set up for each experiment. PCR products were analysed by electrophoresis at 75 V for 2 h in a 0.8% (w/v) agarose gel in 0.5 x TAE buffer (0.4 M Tris, 0.05 M NaAc, 0.01 M EDTA, pH 7.85) and visualised in the gel documentation system (Gene Genius, Syngene, Synoptics Ltd.) following ethidium bromide staining. The PCR products were purified using Wizard PCR Preps (Promega Corporation, Madison, Wisconsin). Both strands of the PCR product were sequenced using the ABI Prism 377 DNA Sequencer (Perkin-Elmer, Norwalk, Connecticut). The cycle sequencing reaction with 20 to 40 ng of DNA template and 3.2 pmol primer in a total volume of 10 µl was carried out with a Dye Terminator Cycle Sequencing Ready Reaction Kit containing AmpliTaq DNA Polymerase (Perkin-Elmer). The reaction was set up as follows: initial denaturation at 94°C for 5 min, followed by 25 cycles of denaturation at 96°C for 10 s, annealing at 55°C for 10 s, extension at 60°C for 4 min in a GeneAmp PCR System 2400 (Perkin-Elmer). The resulting fragments were finally purified using Centri-Sep Spin columns (Princeton Separations, Adelphia, New Jersey) and loaded onto the sequencing gel.

Phylogenetic analysis

In order to test the homology of the DNA sequence data of present and previous studies, a GenBank DNA sequence database search was conducted for each sequence using the Basic BLAST search option of BLAST 2.0 (http://www.ncbi.nlm.nih.gov/BLAST). Nucleotide sequences of 18S and ITS nrRNA gene of *Amphisphaeria umbrina* and GenBank retrievals (Table 1) were assembled using the Tex-Edit Plus programme (tombb@aol.com). Sequences were primarily aligned with Clustal W (Thompson *et al*., 1994) and optimised manually. Alignment gaps were coded as a missing character in the analysis. The manually aligned 22 sequences were subjected to maximum parsimony analysis using the sequence of *Schizosaccharomyces pombe* as an outgroup. Phylogenetic analysis of aligned DNA sequences was performed using PAUP* Version 4.0b2a (Swofford, 1999). The most parsimonious trees were determined from the data sets using the branch and bound method and the heuristic search options with 1000 random sequence input orders with MULPARS on and TBR branch swapping for the exact solution. The unconstrained topologies of the equally parsimonious trees were compared using the Kishino-Hasegawa test. The best topology was selected as the most parsimonious tree topology. The tree stability was evaluated by 1000 parsimony bootstrap replicates in PAUP*. The decay indices were also calculated using AutoDecay (Eriksson, 1998) to further test the robustness of the branches of the tree. Other measures including tree length, consistency, retention, rescaled consistency and homoplasy indexes (TL, CI, RI, RC and HI) were also calculated. Neighbor-joining and maximum-likelihood analyses were also performed in PAUP* to test the parsimonious tree topology.

RESULTS and DISCUSSION

DNA sequence of 1742 nucleotides of 18S subunit of nuclear ribosomal RNA gene of *Amphisphaeria umbrina* have been determined. This sequence was aligned with the sequences of the same gene of other related ascomycetes retrieved from GenBank (Table 1). The partial sequences of *Xylaria curta* (1033 bp) and *X. hypoxylon* (1040 bp) restricted the usage of the complete sequences of other taxa. The alignment (data not shown but available on request from the corresponding author) spans a total of 1141 sites of which 194 ambiguous characters testified in PAUP* were excluded from the analysis. Amongst 947 characters included, there are 692 constant, 124 variable and 131 parsimony informative characters. The maximum parsimony analysis of the dataset with heuristic and branch and bound searches in PAUP* (Swofford,1999) generated 20 equally most parsimonious trees (MPT). In accordance with the result of the Kishino-Hasegawa likelihood test (data not shown), the best tree topology (Fig. 1) of the 20 MPTs was elected and evaluated with 1000 bootstrap replications and decay indices for the clade stability. The final tree (Fig. 1) separates the ingroup taxa into four major clades representing Pyrenomycetes, Loculoascomycetes, Plectomycetes and Discomycetes with strong bootstrap support (100%, 99%, 100%) and decay indices (d10, d10, d13) for the first three and comparatively lower values (75%, d1) for the latter. In the major clade of Pyrenomycetes, *Amphisphaeria umbrina* clustered into the clade of Xylariales with strong bootstrap support (81%) and decay indices (d2), which confirm that the Amphisphaeriaceae (*sensu stricto*) should be placed in the Xylariales. These

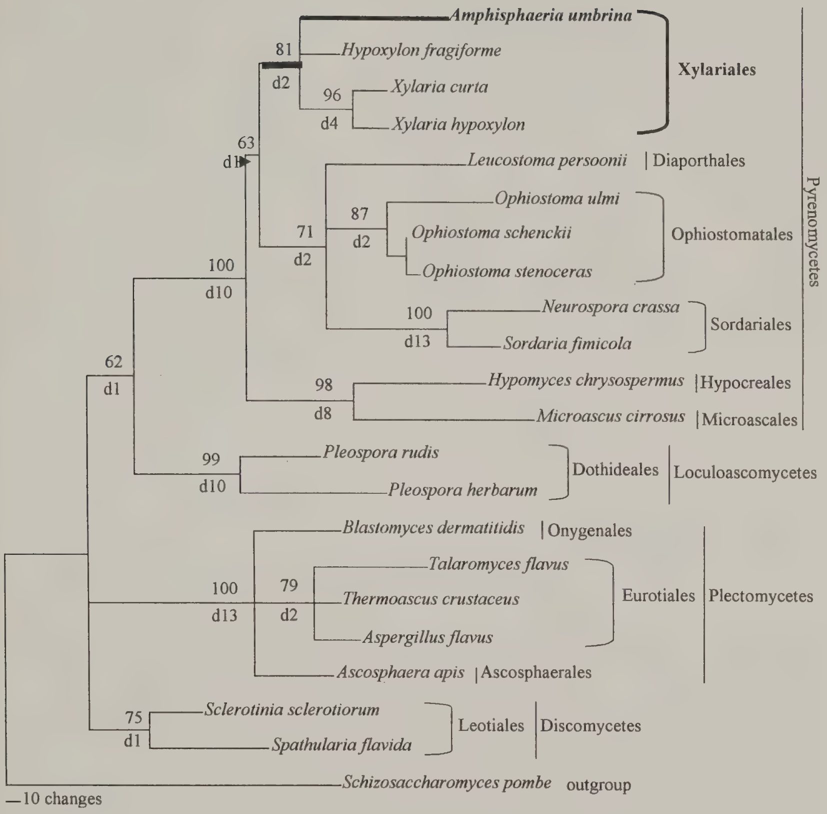
Amphisphaeria umbrina
81
Hypoxylon fragiforme
d2
96
Xylaria curta
d4
Xylaria hypoxylon
Xylariales
63
d1
Leucostoma persoonii
Diaporthales
87
Ophiostoma ulmi
71
d2
Ophiostoma schenckii
d2
Ophiostoma stenoceras
Ophiostomatales
Pyrenomycetes
100
d10
100
Neurospora crassa
d13
Sordaria fimicola
Sordariales
62
d1
98
Hypomyces chrysospermus
Hypocreales
d8
Microascus cirrosus
Microascales
99
Pleospora rudis
d10
Pleospora herbarum
Dothideales
Loculoascomycetes
Blastomyces dermatitidis
Onygenales
Talaromyces flavus
100
79
Thermoascus crustaceus
d13
d2
Aspergillus flavus
Eurotiales
Plectomycetes
Ascosphaera apis
Ascosphaerales
75
Sclerotinia sclerotiorum
d1
Spathularia flavida
Leotiales
Discomycetes
Schizosaccharomyces pombe
outgroup
—10 changes

Fig. 1. One of the 20 MPTs derived from the alignment of the 18S rDNA of 22 taxa using maximum parsimony analysis with branch and bound option. The tree is rooted with the outgroup *Schizosaccharomyces pombe*. TL = 478, CI = 0.651, RI = 0.673, RC = 0.438, HI = 0.349. The bootstrap values representing 1000 bootstrap replicates in branch and bound search and decay indices of heuristic search with 1000 random sequence addition orders are indicated above and below the tree branches, respectively.

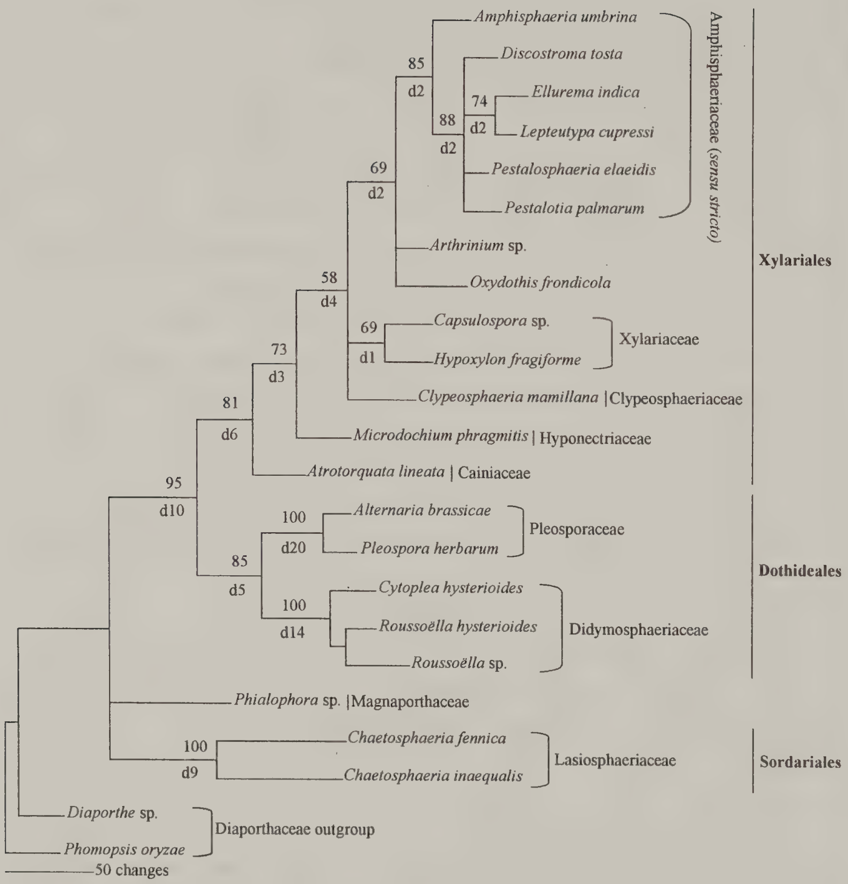
Amphisphaeria umbrina
Discostroma tosta
Ellurema indica
Lepteutypa cupressi
Pestalosphaeria elaeidis
Pestalotia palmarum
Amphisphaeriaceae (sensu stricto)
85
d2
74
d2
88
d2
69
d2
Arthrinium sp.
Oxydothis frondicola
Xylariales
58
d4
69
d1
Capsulospora sp.
Hypoxylon fragiforme
Xylariaceae
73
d3
Clypeosphaeria mamillana | Clypeosphaeriaceae
81
d6
Microdochium phragmitis | Hyponectriaceae
Atrotorquata lineata | Cainiaceae
95
d10
100
d20
Alternaria brassicae
Pleospora herbarum
Pleosporaceae
85
d5
Dothideales
100
d14
Cytoplea hysterioides
Roussoëlla hysterioides
Roussoëlla sp.
Didymosphaeriaceae
Phialophora sp. | Magnaporthaceae
100
d9
Chaetosphaeria fennica
Chaetosphaeria inaequalis
Lasiosphaeriaceae
Sordariales
Diaporthe sp.
Phomopsis oryzae
Diaporthaceae outgroup
50 changes

Fig. 2. One of the 2 MPTs derived from the alignment of the ITS rDNA of 23 taxa using maximum parsimony analysis with branch and bound option. The tree is rooted with the outgroups *Diaporthe* sp. and *Phomopsis oryzae*. TL = 446, CI = 0.491, RI = 0.533, RC = 0.262, HI = 0.509. The bootstrap values representing 1000 bootstrap replicates in branch and bound search and decay indices of heuristic search with 1000 random sequence addition orders are indicated above and below the tree branches, respectively.

Table 1. GenBank accessions of fungal DNA sequences from present and previous studies.

18S rDNA	ITS and 5.8S rDNA
Taxa Accessions	Taxa Accessions
Amphisphaeria umbrina AF225207	*Alternaria brassicae* U05253
Ascosphaera apis M83264	*Amphisphaeria umbrina* AF009805
Aspergillus flavus X78537	*Arthrinium* sp. AJ279479
Blastomyces dermatitidis M55624	*Atrotorquata lineata* AF009807
Hypomyces chrysospermus M89993	*Capsulospora* sp. AF009819
Hypoxylon fragiforme ABO14045	*Chaetosphaeria fennica* AF178562
Leucostoma persoonii M83259	*Chaetosphaeria inaequalis* AF178564
Microascus cirrosus M89994	*Clypeosphaeria mamillana* AF009808
Neurospora crassa X04971	*Cytoplea hysterioides* AF009811
Ophiostoma schenckii M85053	*Diaporthe* sp. AF153737
Ophiostoma stenoceras M85054	*Discostroma tosta* AF009814
Ophiostoma ulmi M83261	*Ellurema indica* AF009816
Pleospora herbarum U05201	*Hypoxylon fragiforme* AJ246218
Pleospora rudis U00975	*Lepteutypa cupressi* AF009817
Schizosaccharomyces pombe X58056	*Microdochium phragmitis* AJ279449
Sclerotinia sclerotiorum X69850	*Oxydothis frondicola* AF009803
Sordaria fimicola X69851	*Pestalosphaeria elaeidis* AF009815
Spathularia flavida Z30239	*Pestalotia palmarum* AF009818
Talaromyces flavus M83262	*Phialophora* sp. AJ132542
Thermoascus crustaceus M83263	*Phomopsis oryzae* AF079777
Xylaria curta U32417	*Pleospora herbarum* U05202
Xylaria hypoxylon U20378	*Roussoëlla hysterioides* AF009812
	Roussoëlla sp. AF009806
	Saccharomyces bayanus AF005710

results also indicate that the common morphological characters including ostiolate ascomata and J+ ring in asci are synapomorphies of the order.

Each sequence of the ITS data set from a previous study (Kang *et al*., 1998) was tested for the homology through a GenBank BLAST search. To prevent DNA sequence ambiguities and/or contaminants being included in GenBank DNA sequence database and phylogenetic analysis, a GenBank BLAST search for each newly generated sequence is essential to confirm the homology of the sequence and find out its phylogenetic allies in GenBank to be included in the subsequent phylogenetic analysis. Only the unambiguous sequences, along with their phylogenetic allies from GenBank DNA sequence database were aligned for phylogenetic analysis. The alignment (data not shown but available on request from the corresponding author) spans a total of 840 sites of which 251 and 125 ambiguous characters at the tips of ITS1 and ITS2 regions, respectively, were excluded from the analysis, due to their non-aligned variation (Kang *et al*., 1998). Amongst 464 characters included there are 147 constant, 81 variable and 236 parsimony informative characters. The maximum parsimony analysis of the alignment using the heuristic search with a 1000 random sequence input orders and the branch and bound search for an exact solution generated 2 MPTs. One of the MPTs was selected as the phylogenetic tree (Fig. 2) through the Kishino-Hasegawa likelihood test (data not shown) and evaluated with 1000 bootstrap replications in a branch and bound search for clade stability. Neighbor-joining and maximum-likelihood analyses were also performed in PAUP* for the alignment which produced an identical tree topology as in the phylogenetic tree (Fig. 2).

In the ITS phylogenetic tree, three major clades representing Xylariales, Dothideales and Lasiosphaeriaceae in Sordariales were formed with strong bootstrap support (81%, 85%, 100%) and decay indices (d6, d5, d9). The node joining Xylariales and Dothideales received strong bootstrap support (95%) and decay indices (d10) which indicated the close phylogenetic relationship between the two orders. The outstanding *Phialophora* of Magnaporthaceae represents a different ordinal lineage. The clades of Pleosporaceae and Didymosphaeriaceae in Dothideales are very strongly supported with bootstrap (100%) and decay indices (d20, d14). The major clade of Xylariales was distinguished from all the other ingroup taxa. In Xylariales, *Atrotorquata* segregated from others and represents Cainiaceae (Kang *et al*., 1999c). *Microdochium* (the anamorph of *Monographella*) represents the lineage of Hyponectriaceae in the order. *Clypeosphaeria* stands for Clypeosphaeriaceae (Kang *et al*., 1999b). *Capsulospora* and *Hypoxylon* clustered together with certain bootstrap value (69%) and decay indices (d1) which may suggest the transfer of *Capsulospora* from Clypeosphaeriaceae (Kang *et al*., 1999b) to Xylariaceae. *Amphisphaeria*, *Discostroma*, *Ellurema*, *Lepteutypa*, *Pestalosphaeria* and *Pestalotia* formed the clade of the Amphisphaeriaceae (*sensu stricto*) with strong bootstrap support (85%) and decay indices (d2) which confirmed the previous phylogenetic study based on the 5.8S nrRNA gene and ITS2 spacer (Kang *et al*., 1998). Furthermore *Arthrinium*, the anamorphic *Apiospora*, as well as *Oxydothis* flanks the clade of the Amphisphaeriaceae (*sensu stricto*) with a support of bootstrap (69%) and decay indices (d2) indicating definite phylogenetic intimacy with the family. The phylogeny of these two genera, however, need to be confirmed by future studies using data from other genomic region(s).

Based on the results of this study and previous molecular and morphological studies, the order name Amphisphaeriales D. Hawksw. & O.E. Erikss. is confirmed to be a taxonomic misnomer. The Amphisphaeriaceae (*sensu stricto*) (Kang *et al*., 1999a), the Clypeosphaeriaceae (Kang *et al*., 1999b) and the Cainiaceae (Kang *et al*., 1999c) should be accommodated in the Xylariales. Hyponectriaceae and Lasiosphaeriaceae are awaiting their phylogeny to confirm intra- and inter-family relationships.

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MORPHOLOGICAL RESPONSES OF CANADIAN AND U.S.A. ISOLATES OF PHOMA SCLEROTIOIDES TO DIFFERENT GROWTH MEDIA, TEMPERATURES AND LIGHT

C.R. Hollingsworth[1], F.A. Gray[2], R.W. Groose[2] and C.W. Mims[3]

[1,2]Department of Plant Sciences, University of Wyoming, Laramie 82071
[3]Department of Plant Pathology, University of Georgia, Athens, 30602, U.S.A.

Abstract: Conclusive identification is provided for a pathogenic Wyoming *Phoma* sp. isolated from roots of alfalfa (*Medicago sativa* ssp. *sativa*). *Phoma sclerotioides*, a fungal pathogen known in Canada to cause disease and winter injury of *Medicago, Melilotus* and *Trifolium* species, is responsible for winter-killed alfalfa in Wyoming. Identification of the Wyoming *Phoma* sp. included morphological comparisons with a Canadian isolate of *P. sclerotioides* obtained from the American Type Culture Collection. Fungal colony response characteristics of the Wyoming and Canadian isolates were closely similar after exposure to different light and temperature regimes on two media. Pycnidial and conidial morphologies also were comparable.

Key words: Brown root rot, *Medicago sativa*, Taxonomy

Introduction

During the spring of 1996, a *Phoma* sp. was isolated from diseased root tissues of irrigated alfalfa (*Medicago sativa* ssp. *sativa*) collected from Farson, Wyoming, located in the southwestern portion of the state (Gray et al., 1997). Farson producers reported increased alfalfa winter mortality with surviving plants requiring an unusually lengthy spring 'green-up' period. Diseased plants displayed cortical rot on upper tap roots with dark circular tap root lesions. Alfalfa root rot symptoms were generally widespread throughout the area.

Brown root rot (BRR) of alfalfa, caused by the plurivorous snow mold *Phoma sclerotioides* (Preuss) ex Sacc. (previously known as *Plenodomus meliloti* Dearness and Sanford), had not been reported from the contiguous United States prior to 1996, but was documented from the Canadian Provinces of British Columbia, Alberta, Saskatchewan, Manitoba and Nova Scotia as well as the Yukon and Northwest Territories. BRR also has been identified from Alaska, Europe and South Australia (Davidson, 1990). Three Wyoming *Phoma* isolates were compared with a known Canadian isolate of *P. sclerotioides* from the American Type Culture Collection (ATCC #56515). Comparative fungal morphologies and growth rates from different substrates were recorded at different temperatures and under different light regimes.

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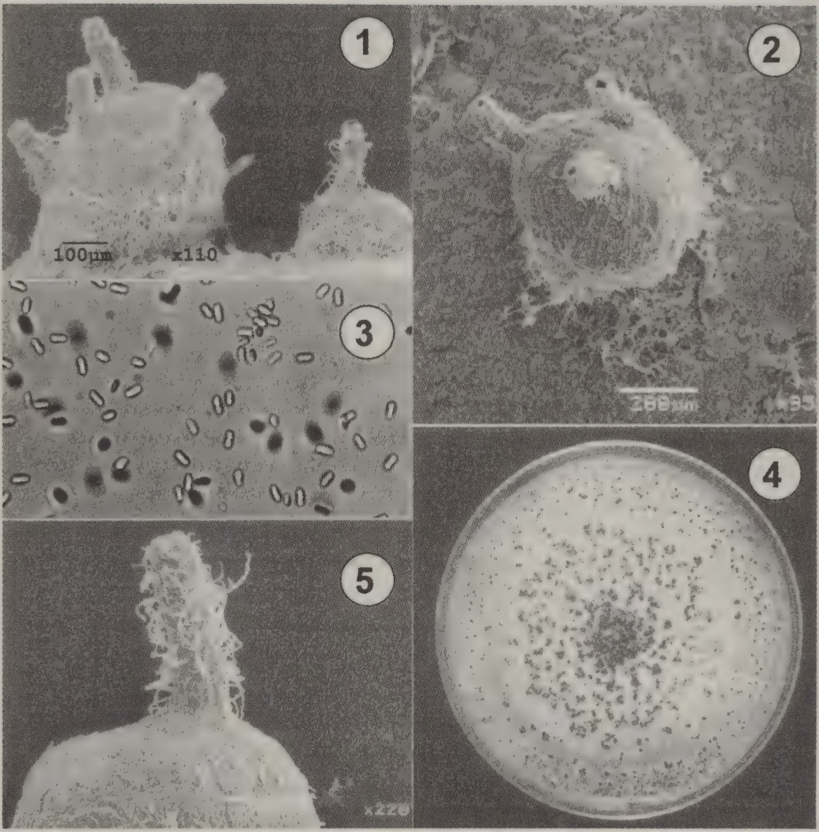
[1]Corresponding author. E-mail address: CharHo@uwyo.edu

Morphological Studies

A *Phoma* sp. was isolated from diseased plants in Wyoming after surface sterilizing root tissues in a 0.01% sodium hypochloride solution (5.25% household bleach) followed by a sterile distilled water rinse. Each procedure lasted three minutes. Surface sterilized tissues were air dried on a sterile filter paper prior to placement in Petri dishes containing a sterile water agar (15%) medium. Isolates were maintained at 10° C for two months. Mature fruiting structures were found on plant tissue as well as scattered throughout the growth medium. Mature pycnidia were dark-colored and flask-shaped with one to several rostra (Figures 1, 2, 5). *In vitro*, pycnidial diameters were large (0.2 - 1.6 mm). Boerema et al. (1994) describe pycnidia of *P. sclerotioides* as relatively large with 0.2-1.0 mm diameters. *In situ*, rostra were variable in length. They ranged from papillae to the approximate length of the diameter of the pycnidium. Conidia were discharged through ostioles at the tips of rostra such as those illustrated in Figure 2. Cirrhi were initially a cream or light-yellow color, but later darkened to a tan or light-brown. Wyoming isolates of *Phoma* sp. produced hyaline, unicellular, elliptical conidia measuring 2.5-3.4 x 4.1-6.5 µm with a mean of 2.9 x 5.5 µm (Figure 3). Canadian research (Smith, 1987) documented conidial dimensions for *P. sclerotioides* as 2-3.5 x 4-8 µm. Conidia varied from eguttulate to multiguttulate (0-4 guttules). When present, guttules were polar (Boerema et al., 1994).

The *Phoma* sp. isolate studied grew well on DIFCO® potato dextrose agar (PDA) and V-8 juice agar (V-8). Growth on PDA generated a plicate, light-green to gray colored zonate thallus (Figure 4). Many variable-sized and mostly superficial pycnidia were produced with loosely lanose rostra (Figure 5). After colony perimeters reached the vertical wall of plastic Petri plates (dia. 90 mm), hyphae generally grew up the plate wall for a short distance where a final ring of extremely small pycnidia were produced. Zafar and Colotelo (1979) suggested this phenomenon could be caused either by contact stimulus of hyphae or by depletion of medium nutrients. To test for contact stimulus, they placed glass beads in Petri plates containing a sterile synthetic medium (for medium content



Figs. 1-5. Wyoming isolate of *Phoma sclerotioides*. **1.** A scanning electron micrograph (SEM) showing an *in vitro* pycnidium with multiple rostra; **2.** Rostra with ostioles as seen in an SEM; **3.** Hyaline, single-celled conidia (400x); **4.** Reproductively mature thallus grown on PDA (0.28x); **5.** Loosely lanose rostrum as seen in an SEM.

see Ward and Colotelo, 1960). They found *P. sclerotioides* produced multiple pycnidia atop bead surfaces that were protruding from the medium. These surfaces had only a thin film of medium present and supported very little aerial mycelium. Zafar and Colotelo (1979) designed another experiment that tested fungal response to depletion of nutrients in light and dark. They placed different amounts of the same sterile synthetic medium into Petri plates (from 1-10 ml, and 20 ml for control plates). The maximum number of pycnidia (170) were produced in the dark on Petri plates containing 3 ml of medium. The number of pycnidia was inversely related to the amount of medium for plates exceeding 3 ml (4 ml = 79; 5 ml = 80; 6 ml = 54; 8 ml = 57; 10 ml = 43; 20 ml = few).

Rostra exhibited negative gravitropism. If Petri plates were inverted to reduce moisture build-up on lids, the general direction of rostra growth was toward the medium. Plates situated in an upright position resulted in rostra growth generally toward plate lids and away from the medium.

Canadian researchers (Zafar and Colotelo, 1969; Zafar, 1970; Zafar and Colotelo, 1979) determined that growth characteristics and responses of *P. sclerotioides* could be altered with different media. Likewise, thalli of the Wyoming *Phoma* sp. exhibited morphological plasticity when grown on different media. Growth on V-8 (made from 200 ml V-8 juice, 15 g agar, 2 g $CaC0_3$, 800 ml distilled water; mixed and autoclaved,) was best described as lanose, producing a thallus much lighter in color than when grown on PDA. An extensive number of small, mostly superficial pycnidia were formed on the agar surface. The period of time required for reproductive maturity was reduced slightly when *P. sclerotioides* was grown on V-8 compared with PDA. The period required for pycnidial maturity was again reduced slightly by growing the fungus on dilute V-8 (made from 170 ml V-8 juice, 17 g agar, 2 g $CaCo_3$, 830 ml distilled water; mixed and autoclaved). This was done to limit available nutrients and promote pycnidial formation. Laboratory observations suggested that corn meal, blood meal and malt extract agars did not promote mycelial growth and pycnidial development of the Wyoming isolate as well as PDA and V-8.

Temperature Studies

Temperature-induced colony growth comparisons were conducted with one Farson, Wyoming *Phoma* sp. isolate and the Canadian isolate of *Phoma sclerotioides* (ATCC #56515). Mycelial plugs (dia. 7 mm) taken from fungal colonies grown on PDA were placed on sterile PDA media. Likewise, plugs from fungal colonies grown on dilute V-8 were placed on sterile dilute V-8 media. Five replicate cultures were maintained at each of four temperatures (-1°, 4°, 10°, and 15° C) for 18 days. Radial growth, measured from the edge of each transfer plug to the outward edge of each colony, was recorded at three day intervals until fungal growth reached the Petri plate wall (dia. 90 mm).

Colony growth comparisons were very similar. Optimal growth was observed at 15° C (Table 1) and 10° C (Table 2). Reduced growth was noted at -1° C (Table 4) while 4° C (Table 3) supported moderate colony growth. These results agree with much earlier Canadian reports (Sanford, 1933) which established cardinal temperatures for *P. sclerotioides* at 0°, 15-16°, and 27° C.

Illumination Studies

The effects of light on growth and sporulation of Lyman, Wyoming (located in the southwest corner of the state) and Boulder, Wyoming (located in the west central area) isolates of *Phoma* sp. were compared with the Canadian isolate of *P. sclerotioides*. A total of ten mycelial plugs were taken from fungal colonies of each isolate and placed on five each Petri plates containing sterile PDA or dilute V-8. Cultures were maintained at 10° C and were either exposed to full illumination (≈ 5,000 foot-candles) or kept in a sealed aluminum foil envelope in the absence of light. Colony growth rates were recorded at three day intervals for a period of 15 days.

Radial colony growth measured from transfer plug perimeter to the advancing mycelial edge was similar for Canadian (Figure 6) and Wyoming (Figures 7, 8) isolates. Each fungal colony from the light treatment displayed dark gray-green pigmentation with limited aerial mycelium, regardless of growth medium. Vegetative development was somewhat slower in light than in dark and occurred primarily within the media. Pycnidial initials were present earlier when the colony was exposed to constant light, but were slow to mature into conidia-bearing pycnidia.

In the dark treatment, Wyoming and Canadian isolates grew white, lanose thalli on both media. Pycnidial initials were produced much later in dark, but advanced to reproductive maturity much sooner than the light treatment. Dark treatment colony effects resulting from brief exposures to light during radial growth readings were unknown. Colony growth appeared to be more affected by light exposure than by growth media (Figures 6, 7, 8).

These results agree with an earlier report by Canadian researchers (Zafar and Colotelo, 1979) who found that pycnidial production in the light began much sooner and colonies produced more pycnidia compared with those grown in the dark. They postulated that a photo-controlled biochemical trigger may be responsible for initiation of pycnidial production *in vitro*. They suggested that cultures grown in the dark apparently lacked necessary metabolic precursors and produced pycnidia only after encountering hyphal contact stimuli (i.e., glass beads or the vertical wall of a Petri plate), or when the amount of medium was severely limited.

Davidson (1990) previously postulated that the pathogen could likely be found at high elevations in the northern U.S. due to its known proximity to the Canada/U.S. border. From our current research, and from previously reported pathogenicity studies (Hollingsworth and Gray, 1999), we conclude the *Phoma* sp. isolated from rotted roots of irrigated alfalfa growing in southwestern Wyoming is *Phoma sclerotioides*, causal agent of brown root rot on alfalfa. This cold-loving fungal pathogen appears well suited to cause disease in areas with long, severe winters. Brown root rot is widespread in much of Wyoming's alfalfa growing areas and may be present in other Rocky Mountain states (Gray et al., 1997).

A pathogenic Wyoming *P. sclerotioides* isolate has been made available through the American Type Culture Collection (ATCC #MYA-295) for researchers.

Tables 1 – 4. Mean radial colony growth comparisons of a Canadian *P. sclerotioides* isolate and a Wyoming *Phoma* sp. on two media (PDA and dilute V-8). Growth comparisons were conducted while colonies were held at four different temperatures. **1.** 15°C; **2.** 10°C; **3.** 4°C; **4.** -1°C.

Table 1.

		Mean radial colony growth (mm) at 15°C					
		Days					
Isolate	Medium	3	6	9	12	15	18
ATCC	PDA	3.4	5.8	16.2	21.4	25.4	32.2
WYO	PDA	3.6	9.6	15.6	22	25.8	32.2
ATCC	dV-8	3.2	10.4	16.2	24.4	29.2	38.8
WYO	dV-8	3.2	10.8	18.2	24.8	30.0	38.8

Table 2.

		Mean radial colony growth (mm) at 10°C					
		Days					
Isolate	Medium	3	6	9	12	15	18
ATCC	PDA	2.2	9.2	16.2	20.2	24.4	39.2
WYO	PDA	2.6	8.8	15.4	21.0	25.2	32.6
ATCC	dV-8	2	9.8	16.8	24.2	29.6	31.2
WYO	dV-8	1.6	10.2	17.8	24.8	29.8	38.8

Table 3.

		Mean radial colony growth (mm) at 4°C					
		Days					
Isolate	Medium	3	6	9	12	15	18
ATCC	PDA	0.0	1.4	4.6	9	11	14.8
WYO	PDA	0.1	2.2	6.2	9.8	12.0	16.0
ATCC	dV-8	0.0	1.8	4.8	8.8	12.0	17.0
WYO	dV-8	0.0	1.6	5.0	9.4	12.8	17.0

Table 4.

		Mean radial colony growth (mm) at -1°C					
		Days					
Isolate	Medium	3	6	9	12	15	18
ATCC	PDA	0.0	1.0	1.6	3.4	4.8	6.6
WYO	PDA	0.0	0.0	1.0	3.2	4.6	6.4
ATCC	dV-8	0.0	1.0	1.6	2.8	4.6	7.0
WYO	dV-8	0.0	1.0	1.2	2.0	4.2	7.2

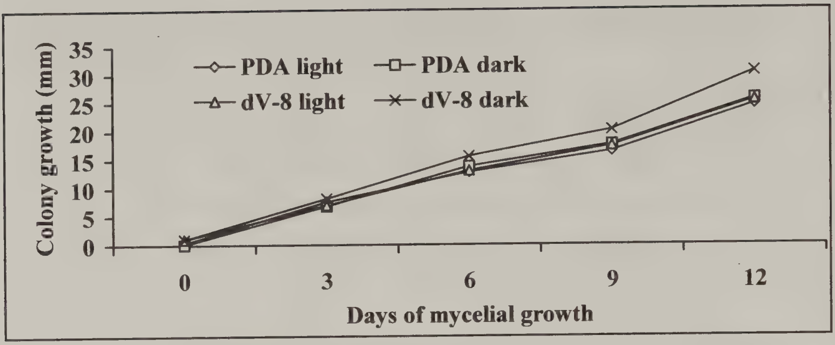


Figure 6. Mean radial colony growth of an ATCC isolate when grown on PDA and dilute V-8 with light or dark exposure.

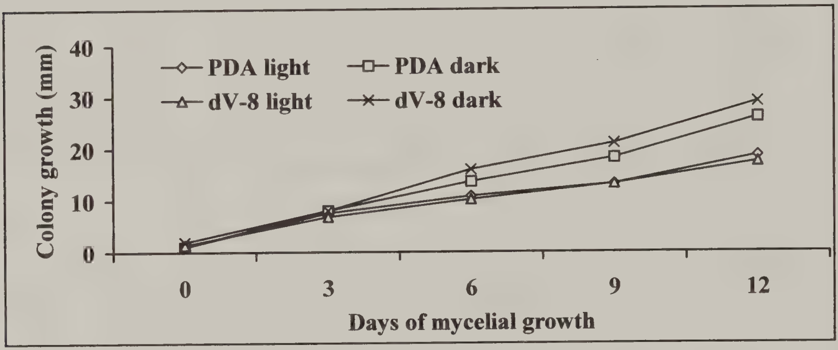


Figure 7. Mean radial colony growth of Lyman, Wyoming isolate when grown on PDA and dilute V-8 with light or dark exposure.

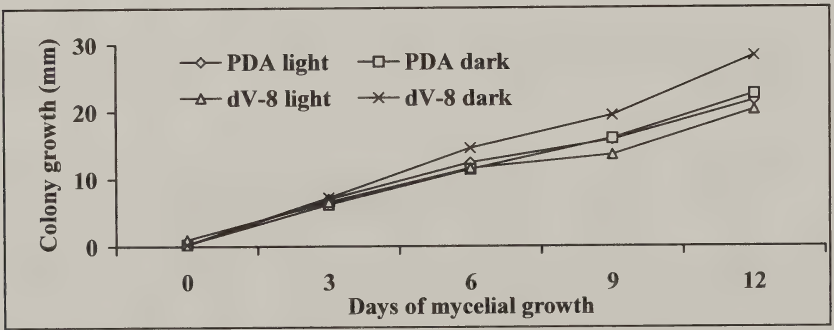


Figure 8. Mean radial colony growth of Boulder, Wyoming isolate when grown on PDA and dilute V-8 with light or dark exposure.

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A NEW SPECIES OF PHACELLIUM ON ALANGIUM

HYEON-DONG SHIN
Division of Environmental Science and Ecological Engineering,
Korea University, Seoul 136-701, Korea
<E-mail: hdshin@korea.ac.kr>

and

JEONG-DONG KIM
Institute of Life Science and Technology,
Sungkyunkwan University, Suwon 400-746, Korea
<E-mail: jdkim@nature.skku.ac.kr>

ABSTRACT: *Phacellium alangii* sp. nov., associated with leaf blotch of *Alangium platanifolium* var. *macrophylum*, is described, illustrated and compared with three cercosporoid species recorded on *Alangium* spp. previously.

Keywords: Mycoflora, Cercosporae, Korea

In the course of taxonomic studies for a critical revision of the local records of *Cercospora* spp. and taxa of allied genera from Korea (Shin and Kim, 2001), a fungus associated with leaf blotch of *Alangium platanifolium* var. *macrophylum* (Sieb. & Zucc.) Wanger. was determined to be an undescribed species of *Phacellium* Bonord. sensu Braun (1988, 1998). This new species is described, illustrated and compared with three cercosporoid fungi that have been recorded on *Alangium* spp.

***Phacellium alangii* H.D. Shin & J.D. Kim**, sp. nov. (Fig. 1)

Maculae amphigenae, discretae, interdum confluentes, indistinctae, angulares vel irregulares, 3-20 mm diam., interdum per venas limitatae. Conidiomata hypophylla, synnematalia, solitaria, dilute olivacea. Mycelium immersum; hyphae septatae, ramosae, hyalinae vel dilutissime olivaceae. Synnemata erecta, ex stromate oriunda, per stoma emergentia, 90-340 x 20-50 µm, primo laxa, deinde dense aggregata, subcylindrica, ad basim pallide olivacea vel olivaceo-brunnea, apicem versus pallidiora, interdum omnino pigmentosa; conidiophora 2-3 µm lata, 3-12-septata, simplicia vel 1-6-ramosa; cellulae conidiogenae terminales et pleurogenae, subrectae vel interdum sinuosae, apice geniculatae, hyalinae; cicatrices conidiales conspicuae, parvae, incrassatae, fuscae. Conidia solitaria, catenata vel ramicatenata, cylindrica vel ellipsoida, leniter fusiformia, recta, hyalina, aseptata, interdum uniseptata, ad septum non constrictae, utrimque obtusa vel subobtusa, 5-42 x 2-5 µm; hila incrassata, fuscata, non eminentia.

Leaf spots amphigenous, scattered, occasionally confluent, indistinct, usually angular to irregular, small to large, 3-20 mm diam., up to 40 mm when coalescent, sometimes vein-limited, initially effuse to discolored to greenish yellow, later forming greenish brown to pale brown blotches with yellowish brown halo on the upper surface, somewhat velvety to cottony due to scattered blackish dots caused by the fungal fructification on the lower leaf surface. Conidiomata hypophyllous, synnematous, solitary, pale to somewhat pigmented. Mycelium internal; hyphae septate, branched, hyaline to faintly pigmented. Synnemata erect, arising from stromata, emerging through stomata, 90-340 x 20-50 µm, at first rather loose, but later densely aggregated, forming firm stalks, subcylindrical, composed of numerous compact parallel conidiophores, apically splaying out, pale olivaceous to olivaceous brown at the base, paler towards the apex, sometimes pigmented almost throughout; individual conidiophores 2-3 µm wide 3-12-septate, simple or with up to 6 branches; conidiogenous cells terminal as well as pleurogenous, almost straight to partly sinuous, geniculate at the apex, hyaline or almost so; conidial scars conspicuous, small, thickened and darkened. Conidia solitary, sometimes in short branched or unbranched chains, cylindrical to ellipsoidal or fusiform, straight, hyaline, usually aseptate but occasionally uniseptate, non-constricted at the septa, obtuse to subobtuse at both ends, 5-42 x 2-5 µm; hilum conspicuously thickened, darkened, and non-protuberant.

Holotypus: On living leaves of *Alangium platanifolium* var. *macrophylum* (Sieb. & Zucc.) Wanger. [Alangiaceae], Chunchon, S. Korea, Shin, 29 IX 2000 (SMK 17673).
Isotypus: HAL 1656.

Notes: Three cercosporoid fungi have been described on host species of *Alangium* from China (Guo & Liu, 1989; Guo, 1992) and India (see Braun, 1998). They are clearly different from the present fungus described here as a new species. *Cercospora alangii* Y.L. Guo (1992) on *Alangium chinensis* (Lour.) Harms. is a true *Cercospora* s. str. with conspicuous conidial scars and hyaline scolecosporous conidia. *Pseudocercospora alangii* Y.L. Guo and X.J. Liu (1989) on *A. kurzii* Craib is distinguished by having well-developed stromata, creeping superficial secondary mycelium, short conidiophores and pigmented conidia. *Ramularia alangii* Hasija (see Braun, 1998) on *A. lamarckii* Thw. has short, hyaline conidiophores and catenate conidia.

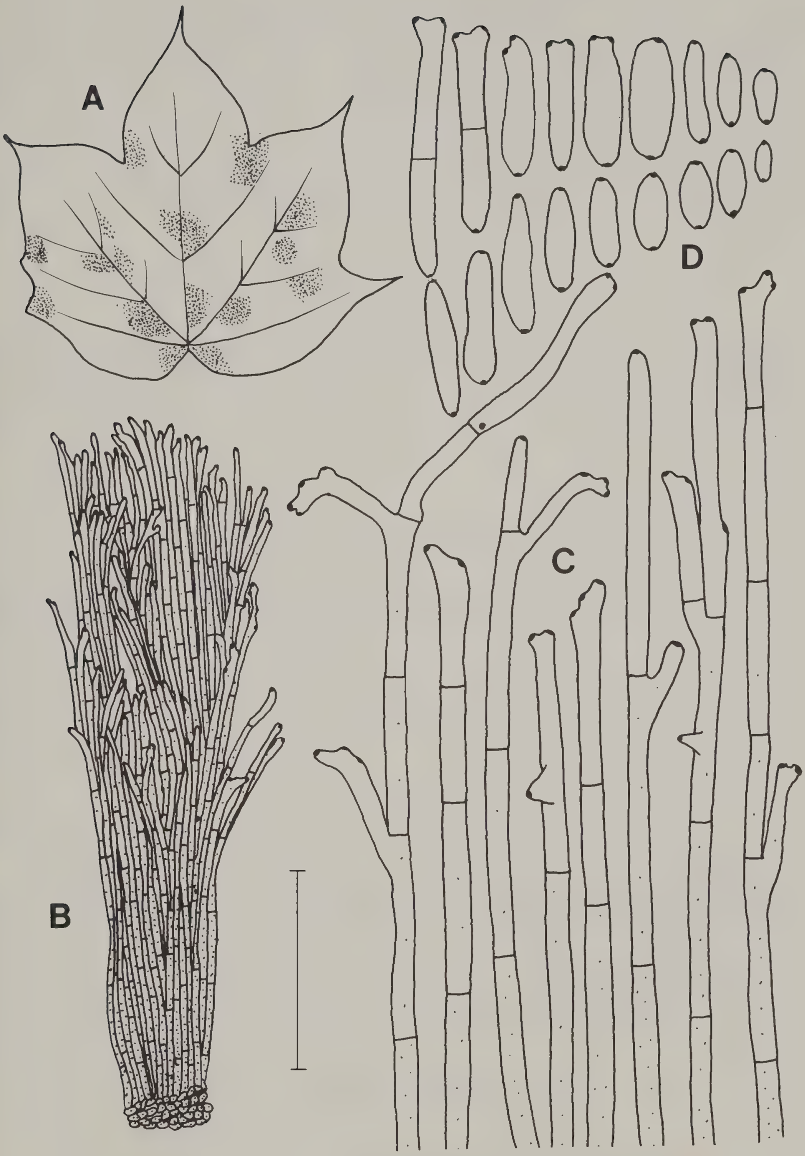

Fig. 1. *Phacellium alangii* H.D. Shin & J.D. Kim: **A**, Leaf spots on the lower leaf surface of *Alangium platanifolium* var. *macrophylum* (0.3×). **B**, Synnematous conidiophore. **C**, Upper portion of conidiophores, **D**, Conidia. Scale bar represents 75 μm for B and 30 μm for C & D.

On *Alangium* and allied genera, there is no comparable species possessing synnematous conidiophores as in *Phacellium* and the allied genus *Tandonella*. Sutton and Pascoe (1987) stated that *Tandonella* is very close to *Phacellium* but differs by having pigmented conidiogenous cells and conidia. The present species is well characterized by synnemata pigmented only at the base, colorless conidiogenous cells and conidia, and terminal to pleurogenous conidiogenous cells. These features agree with Braun's (1998) concept of *Phacellium*.

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CORTICOLOUS MYXOMYCETES ASSOCIATED WITH FOUR TREE SPECIES IN MÉXICO

MERCEDES RODRÍGUEZ-PALMA[1], ADALID VARELA-GARCÍA[1] & CARLOS LADO[2]

1. Centro de Investigación en Ciencias Biológicas, Universidad Autónoma de Tlaxcala. Km. 10.5 carr. Texmelucan-Tlaxcala, Ixtacuixtla. 90122. Tlaxcala, México.
2. Real Jardín Botánico de Madrid (CSIC), Plaza de Murillo, 2. 28014 Madrid, España. e-mail: lado@ ma-rjb.csic.es

Abstract

Results obtained from 108 moist chamber cultures with bark from living trees of four species of the Mexican temperate forests, *Abies religiosa, Juniperus deppeana, Pinus pseudostrobus* and *Quercus crassipes,* are presented. A total of 23 species of myxomycetes were recognized, of which seven are first records for Mexico. *Clastoderma pachypus*, *Echinostelium apitectum* and *E. brooksii* are new species for the Neotropics, and information on the presence of *Licea nannengae* in the American Continent is reported here for the first time. Some questions are raised on the variation of *Comatricha laxa.*

Key words: Bark culture, Neotropics, distribution, taxonomy.

Resumen

Se presentan los resultados obtenidos a partir de 108 cultivos en cámara húmeda realizados con cortezas de 4 especies arbóreas, *Abies religiosa, Juniperus deppeana, Pinus pseudostrobus* y *Quercus crassipes,* de los bosques templados del centro de México. Se han reconocido un total de 23 especies de Myxomycetes, de las cuales, siete se registran por primera vez para México. *Clastoderma pachypus*, *Echinostelium apitectum* y *E. brooksii* son nuevas citas para la región Neotropical y se aportan los primeros datos sobre la presencia de *Licea nannengae* en el continente americano. Se tratan algunas cuestiones sobre la variación morfológica de *Comatricha laxa*.

Palabras clave: Cultivo de cortezas, Neotrópico, distribución, taxonomía

Introduction

The bark from living tree trunks and branches are a habitat for certain species of myxomycetes (Ing, 1994). Because of their small size, which in many cases does not exceed 0.5 mm in height, the observation of these myxomycetes in the field is limited. The moist chamber technique was chosen for this investigation because of its proven usefulness in the study of this group of organisms (Keller & Brooks, 1977; Härkönen, 1977; Whitney, 1980; Stephenson, 1989).

The first and only studies on the corticolous myxomycetes of Mexico were made by Braun & Keller (1976, 1986) and Keller & Braun (1977), in which a total of 25 different taxa are reported for the different states (Table I). The shortage of information and our interest in complementing the field studies which were recently carried out in the State of Tlaxcala (Galindo-Flores, 1993; Hernández-Cuevas, 1993; Rodríguez-Palma, 1992; 1996; Varela-García, 2000), motivated us to investigate the species of myxomycetes associated with four widely distributed and common tree species of the State and the temperate forests of Central Mexico.

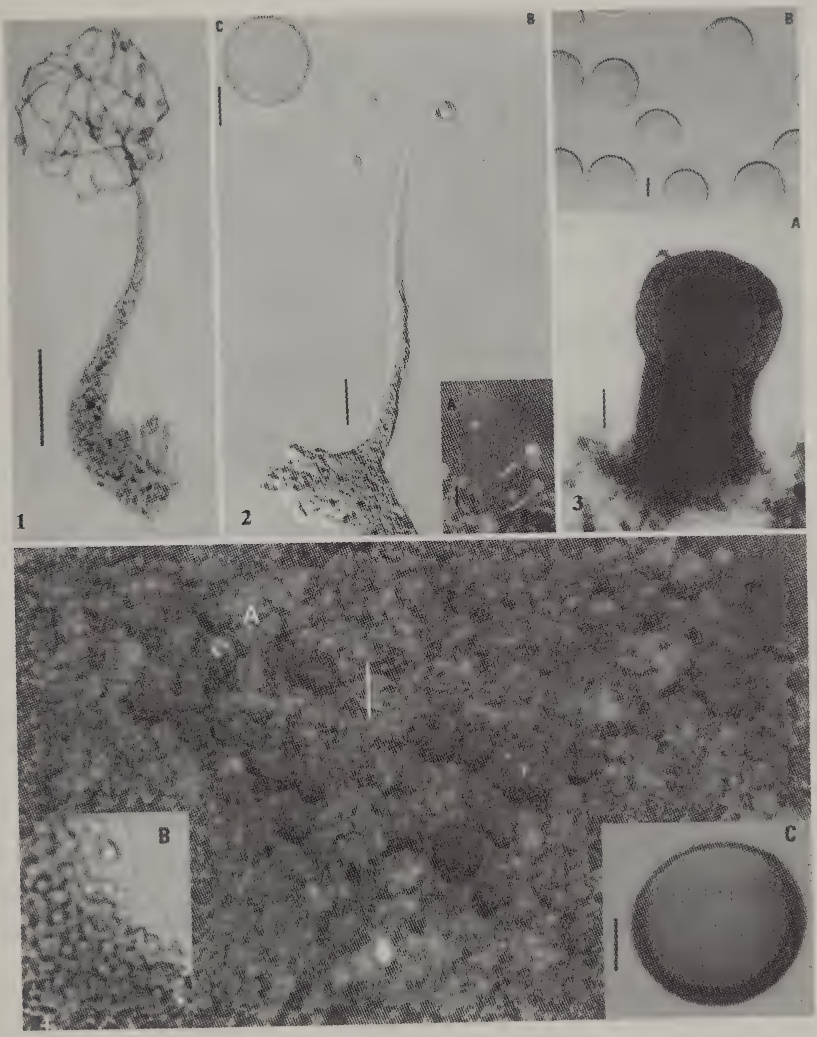
Table 1. Corticolous Myxomycetes Previously Known from Mexico

Species	State	Reference
Calomyxa metallica	Distrito Federal	Keller & Braun, 1977
Clastoderma debaryanum	Quintana Roo	Braun & Keller, 1986
Colloderma robustum	Distrito Federal	Braun & Keller, 1986
Cribraria microcarpa	Veracruz	Braun & Keller, 1986
C. violacea	Guerrero, Puebla, Tabasco, Yucatán	Braun & Keller, 1976, Keller & Braun, 1977
Dianema sp.	Puebla	Keller & Braun, 1977
Diderma chondrioderma	Yucatán	Keller & Braun, 1977
Didymium clavus	Yucatán	Keller & Braun, 1977
D. difforme	Distrito Federal	Keller & Braun, 1977
Echinostelium arboreum	Yucatán	Keller & Braun, 1977,Keller &Brooks, 1976
E. elachiston	Yucatán	Braun & Keller, 1986
E. minutum	Guerrero, Morelos, Puebla, Yucatán	Braun & Keller, 1976, Keller & Braun, 1977
Enerthenema papillatum	Distrito Federal	Braun & Keller, 1986
Licea castanea	Yucatán	Keller & Braun, 1977, Braun & Keller, 1986
L. kleistobolus	Distrito Federal	Braun & Keller, 1986
L. minima	Estado de México, Tlaxcala	Braun & Keller, 1976
L. operculata	Veracruz	Braun & Keller, 1986
L. pedicellata	Guerrero,Morelos, Yucatán	Keller & Braun, 1977
L. pseudoconica	Yucatán	Keller & Braun, 1977
Macbrideola cornea	Guerrero, Yucatán	Keller & Braun, 1977
M. decapillata	Puebla	Keller & Braun, 1977
Paradiacheopsis fimbriata	Veracruz	Braun & Keller, 1986
Perichaena chrysosperma	Guerrero	Keller & Braun, 1977
P. depressa	Morelos, Puebla, Yucatán	Braun & Keller, 1976, Keller & Braun, 1977
Physarum compressum	Morelos	Keller & Braun, 1977

Materials and Methods.

Bark from living trees of four common species of the temperate forests of the State of Tlaxcala, Mexico (*Abies religiosa, Juniperus deppeana, Pinus pseudostrobus* and *Quercus crassipes*) were collected. Samples were taken at 1.5 m above ground level and transported to the laboratory in paper bags. Five bark fragments were mounted per moist chamber culture plate. A total of 108 cultures were prepared (27 chambers per tree species) and observed according to the indications proposed by Mitchell (1977).

Because of the small size of the sporophores, permanent preparations were mounted using Hoyer´s medium, in order to continue with their identification. All samples were deposited at the TLXM herbarium of the Universidad Autónoma de Tlaxcala (Mexico), with some duplicates deposited at the MA-Fungi herbarium of the Real Jardín Botánico of Madrid, Spain. For the color characterization a Methuen table of colors was used (Kornerup & Wanscher, 1978)



Figs. 1-4. 1. *Clastoderma pachypus*, VG 427. Sporocarp (bar 80 µm). 2. *Echinostelium apitectum*, VG 420. A. Group of sporocarps (bar 1 mm). B. Sporocarp (bar 40 µm). C. Spore (bar 4 µm). 3. *Licea scyphoides*, VG 448. A. Sporocarp (bar 50 µm). B. Spores (bar 8 µm). 4. *L. nannengae*, VG 446. A. Group of sporocarps (bar 0.3 mm). B. Peridium. C. Spore (bar 4 µm).

SPECIES LIST

Arcyria cinerea (Bull) Pers.

Studied material: On *Abies religiosa,* Varela-García 317, 325, 340. On *Pinus pseudostrobus*, Varela-García 332, 474, 475. On *Juniperus deppeana*, Varela-García 345.

Arcyria pomiformis (Leers) Rostaf.

Studied material: On *Pinus pseudostrobus*, Varela-García 321, 322, 324.

Only 1 or 2 sporocarps have been found in each collection, exclusively on *Pinus* bark.

Calomyxa metallica (Berk.) Nieuwl.

Studied material: On *Juniperus deppeana*, Varela-García 401, 423, 563, 672, 673, 674, 683.

In other parts of the world, it has been registered on the bark of different trees such as *Aesculus*, *Alnus, Acer, Castanea, Fagus, Fraxinus, Ilex, Pinus, Populus, Quercus, Sambucus, Tilia, Ulmus* (Ing, 1994); *Morus, Populus nigra, P. tremula, Quercus petraea* and *Tilia* (Ing, 1997). In Mexico, it had been reported on *Taxodium mucronatum* (Keller & Braun, 1977).

Clastoderma pachypus Nann.-Bremek.

Studied material: On *Abies religiosa,* Varela-García 427.

Only three sporocarps have appeared which measured 380-400 µm in total length, their sporothecae were globose, 110-120 µm diam.; the stalk 270 to 290 µm in length, with a broad base that tapered towards the apex, of bright yellow color (4A5) by transmitted light, lightly marked with longitudinal lines in the apical portion and with granular material filling up to 25-75% of the basal portion; Peridium remaining as a basal cup of 12-13 µm diam; the columella was cylindrical and reached only 1/5 to 1/6 of the total length of the sporotheca; the capillitium which arose from the columella, was scarce and arose from 3-4 primary branches that ramified and anastomosed to give rise to a small complete net at the periphery (fig. 1). Spores were free, dark brown in mass, from yellowish brown (5E4) to brownish gray (5E2) by transmitted light, globose-crested, of 11-12 (-14.5) µm diam. and warted.

Ing (1994) points out that this species seems to be confined to *Quercus* bark, although he admits that it may have a broader distribution in the tropics. In our case, it was found on *Abies* bark. Keller & Braun (1999) reported the species from the United States. They comment that this species is rare and restricted to the bark of living trees and vines found in Arkansas, California and Ohio. This is the first record for Mexico and the Neotropics.

Comatricha laxa Rostaf.

Studied material: On *Pinus pseudostrobus,* Varela-García, 341, 342, 371, 372, 375, 379, 381, 382, 384, 385, 386, 388, 392, 396, 406, 408, 410, 433, 434, 435, 437, 439, 448, 450, 452, 453, 454, 459, 460, 466, 470, 502, 513, 514, 515, 518, 519, 520, 532, 533, 571, 573, 577, 578, 579, 580, 581, 582, 583. On *Abies religiosa,* Varela-García: 297, 413, 414, 417, 495, 509, 511, 541, 547, 549, 586, 599, 662, 663, 667, 706. On *Juniperus deppeana,* Varela-García 268, 344, 360, 679. On *Quercus crassipes*, Varela-García: 304.

We have grouped under this binomial numerous specimens, of a generally disperse habit; minute, 0.6-1 mm in total length, with sporotheca of 0.3 to 0.4 mm diam., and with spores of 10-13 µm diam., warted, collected on the four substrates studied, they fit well the sketches Mitchell (1978) made for corticolous species such as *Paradiacheopsis solitaria* (Nann.-Bremek.) Nann.-Bremek., *P. cribrata* Nann.-Bremek., *P. acanthodes* (Alexop.) Nann.-Bremek., *P. microcarpa* (Meyl.) D.W. Mitch. ex Ing, *P. rigida* (Brandza) Nann.-Bremek. (originally described as a variety of *Comatricha laxa* Rostaf.), *C. ellae* Härk. or small types such as *C. laxa*.

In our material we have been able to recognize two predominant morphological types: 1) those with a subglobose or subcylindrical sporotheca, and a dense, branched and anastomosed capillitium arising from a few branches disposed along the columella, as well as from its apex; and 2) those with a globose sporotheca, and a scarce capillitium with few branches and anastomoses, which arise mainly from 2-3 primary branches at the apex of the columella. The first one fits well the illustration Mitchell (1978) made of the small types of *C. laxa* (pl.13, fig. 83), and the second one with that of *P. rigida* (pl. 12, fig. 79b) or with Celakovsky's (1893) illustrations of the globose types of *C. laxa.* In all cases, a tendency towards a small collar at the base of the sporotheca was found, which can be interpreted as a residue of the peridium or as thin branches of the capillitium which arise from the very base of the sporotheca. However, we have also found, depending on the degree of maturity of the sporocarps, a series of intermediate states, as well as types with barely any capillitium or slightly anastomosed which could be classified as different species such as *P. acanthodes, P. microcarpa* or *P. solitaria*. The morphological variability of *C. laxa* has been widely admitted and its implication with some of the species mentioned above have all ready been discussed by authors such as Rostafinski (1874), Lister (1925), Martin & Alexopoulos (1969), Härkönen (1977), Nannenga-Bremekamp (1991) or Castillo *et al.* (1997). Mitchell (2000) also commented on the morphological variability of *C. laxa*, emphasizing that sporocarps can vary a great deal both in size and in the intricacy of the internal capillitium. The author distinguishes three species, *C. laxa, C. ellae* and *Paradiacheopsis cribata*, because *C. ellae* always presents a well defined peripheral net and its spores have a large and distinct germinative area. *Paradiacheopsis cribata* has larger and more strongly decorated spores. However, we have found such a high degree of variability that we doubt the taxonomic entity of these species and we do not know to what extent they may actually represent a wide variation of *C. laxa*. For these motives, while awaiting further studies, among which we would consider the culture of these species as well as a cladistic analysis that could clarify its taxonomic position, we prefer to consider them within a broad concept of *C. laxa.*

Comatricha nigra (Pers. ex J. F. Gmel.) J. Schröt.

Studied material: On *Abies religiosa*, Varela-García 411, 412, 413, 414b, 415, 416, 427, 429, 442, 508, 584, 586b, 591, 594, 701. On *Pinus pseudostrobus,* Varela-García 284, 285, 468, 469, 472, 476, 570, 572, 690, 691.

In Härkönen's research (1977), the preference of this species for coniferous tree bark, specifically *Larix* and *Pinus*, is noted; however its presence on other substrates such as *Pinus, Pseudotsuga, Thuja, Alnus, Populus, Sorbus, Crataegus, Ulmus, Betula* and *Quercus*, is also mentioned. In our case, it was found abundantly on *Abies* and *Pinus.*

Cribaria violacea Rex

Studied material: On *Juniperus deppeana,* Varela-García 268, 273, 274, 499, 681.

This species is widely distributed in Mexico (Illana *et al.*, 2000), where it has been recorded on *Juniperus, Casuarina equisitifolia,* red cedar and *Salix chilensis* bark (Keller & Braun, 1977). We detected it only on *Juniperus deppeana* bark.

Echinostelium apitectum K. D. Whitney

Studied material: On *Abies religiosa*, Varela-García 317, 325, 362, 370, 383, 399, 420, 455, 493, 539, 544, 599, 660. On *Pinus pseudostrobus,* Varela-García 269, 271, 530, 531. On *Juniperus deppeana,* Varela-García 294, 295, 373. On *Quercus crassipes,* Varela-García 289,568.

The studied specimens grew on the four substrates that were analyzed, frequently together with *E. minutum* de Bary. The most outstanding features of this material were the 96-400 µm tall stalked sporocarps (fig. 2A), and the globose sporotheca of 26-54 µm diam.; the stalk tapers and curves slightly near the apex, golden yellow (5B6) in color by transmitted light and contains granular material in 2/3 of the basal portion (fig. 2B). The peridium is partially fugacious and persists in the shape of a small basal disk, frequently ending in a spore-like body. Spores free, yellowish white (1A2) by transmitted light, globose, 6-10 µm diam., smooth with a uniformly thick spore wall (fig. 2C). Whitney (1980) reports larger spores (10–12 µm diam.), however, Lado & Pando (1997) in a study of Iberian material have extended the size range to 6-12 µm diam., values within which our specimens fit.

This species is reported for the first time in Mexico and is a new record for the Neotropical region.

Echinostelium brooksii K.D. Whitney

Studied material: On *Abies religiosa* , Varela-García 546.

Only one sporocarp was detected, intermixed with *E. apitectum* and *E. minutum*. The sporocarp presented the following features: a total height of 140 µm, a globose sporotheca of 35.5 µm diam.; the stalk reached 100 µm in length, with an expanded base tapering to the apex, hyaline with barely any granular material; the peridium persisted as a small basal collar; the columella was pedunculate and hemispheric, 4 µm in diameter, without a spore-like body or associated capillitium. Spores were free, yellowish white (4A2) by transmitted light, globose, almost smooth, 11-12 µm diam. Whitney (1980) described the spores as pink to hyaline by transmitted light, and Lado & Pando (1997) as hyaline to pinkish-yellowish gray; in our case, they were yellowish white, yet the typical shape of the columella and the size of the spores eliminates possible confusion.

It is a new record for the Neotropics.

Echinostelium minutum de Bary

Studied material: On *Pinus pseudostrobus,* Varela-García 267, 276, 278, 281, 282, 286, 288, 306, 307, 308, 309, 310, 313, 315, 326, 336, 348, 354, 394, 395, 434, 436, 478, 574, 692, 693, 723. On *Abies religiosa*, Varela-García 398, 483, 494, 496, 497, 505, 545. On *Juniperus deppeana,* Varela-García 270.

The sporocarps appeared abundantly during the first week of incubation, forming colonies of 30 to 60. The species was already known in Mexico in the States of Guerrero, Morelos, Nuevo León, Puebla and Yucatán (Keller & Braun, 1977; Ogata *et al.*, 1994). We have found them occurring copiously on the bark of the studied conifers, which corroborates Härkönen's (1977) and Keller & Braun's (1977) results, however it has not appeared on the *Quercus crassipes* bark.

Enerthenema papillatum (Pers.) Rostaf.

Studied material: On *Pinus pseudostrobus,* Varela-García 279, 404, 405, 406, 480, 514. On *Abies religiosa,* Varela-García 366, 506, 661.

Härkönen (1977) points out that this is a species that prefers the bark of conifers such as *Picea abies*. Ing (1997) considers this species to be common on acidic bark and mentions its presence on *Acer, Aeusculus, Morus, Picea, Populus, Quercus* and *Tilia.* In our study it was found only on *Abies* and *Pinus* bark.

Licea castanea G. Lister

Studied material: On *Juniperus deppeana* bark, Varela-García 346, 464, 471, 561, 726.

Keller & Braun (1977) also obtained this species on *Juniperus* bark in Yucatan and referred to it as *Licea* sp.; later on, this material was confirmed by the same authors (Braun & Keller, 1986) to represent *L. castanea.*

Licea kleistobolus G. W. Martin

Studied material: On *Pinus pseudostrobus,* Varela-García 447, 477; On *Juniperus deppeana,* Varela-García

This species appears on the first 7 days of culture and reaches its maturity during the second week. According to various authors (Ing, 1994, 1997; Stephenson, 1989), it seems to be a frequent species on the bark of conifers and broad-leaved trees, but in this case it was only found on the conifers studied. In Mexico it had been reported only for the Distrito Federal (Braun & Keller, 1986) although Illana & *al*. (2000) mention they have knowledge of some unpublished specimens from Baja California. Ing & Haynes (1999) reported it from Belize.

Licea minima Fr.

Studied material: On *Abies religiosa,* Varela-García 334.

Although considered to be a frequent species (Ing, 1997), in our study it has appeared on only one occasion on *Abies religiosa* bark. Braun & Keller (1976) reported it previously in Tlaxcala on *Pinus* bark.

Licea nannengae Pando & Lado

Studied material: On *Juniperus deppeana*, Varela-García 301, 446, 484, 485. On *Pinus pseudostrobus*, Varela-García 492. On *Abies religiosa*, Varela-García 704. On *Quercus crassipes*, Varela-García 728.

This species appeared frequently on *Juniperus deppeana* bark. In most specimens, the sporocarps appeared scarcely aggregated and sessile; the sporotheca varied between globose to slightly pulvinate, reaching up to 0.3 mm diam. (fig. 4A); the peridium possessed sparse or very abundant granular material adhered to its surface (fig. 4B), with no peridial platelets but forming small ridges when the sample dried. These ridges might give the impression of delimiting the plates as in *L. castanea* G. Lister, *L. deplanata* Kowalski or *L. minima* Fr., but in our case, the dehiscence lines characteristic of these other species do not appear. The spores were smooth, olivaceous brown by transmitted light with a thinner portion of the wall (fig. 4C).

The presence of this species in the cultures was detected during the third week of incubation, usually intermixed with *L. parasitica* (Zukal) G. W. Martin.

Keller & Braun (1999: 57) cited some material of United States as *Licea* cf. *nannengae*. They mention its proximity with *L. castanea* and indicate that characteristics of the two species overlap. In the description of their specimens, Keller & Braun mention the presence of two layers, the outer layer thickened with deposits of granular matter and divided into platelets by distinct black ridges, the inner layer membanous, hyaline with a smooth inner surface. However, *Licea nannengae* has a single peridium and the peridial platelets are absent (Lado & Pando, 1997).

This is the first record of this species for the American continent.

Licea parasitica (Zukal) G.W. Martin

Studied material: On *Juniperus deppeana*, Varela-García 295, 300, 302, 426, 431, 446, 456, 462, 486, 528, 564. On *Quercus crassipes*, Varela-García 298, 421, 444, 685. On *Abies religiosa*, Varela-García 504, 705. On *Pinus pseudostrobus*, Varela-García 503, 575.

This species develops on numerous tree substrates such as *Prunus, Betula, Quercus, Acer, Carya, Amelanchier, Fagus* (Stephenson, 1989), *Chamaecyparis, Corylus, Cytisus, Ilex, Juniperus, Malus, Sambucus, Sorbus* (Ing, 1994), *Abies, Aesculus, Castanea, Catalapa, Cupressus, Fraxinus, Larix, Liquidambar, Picea, Pinus, Populus, Pterocarya, Pyrus, Robinia,* various species of *Quercus, Tilia* and *Ulmus* (Ing, 1997). Our study confirms this since it was found on the 4 types of bark analyzed. In Mexico it has been reported only for the State of Tlaxcala (Rodríguez-Palma, 1998). Recently, Ing & Haynes (1999) reported it from Belize.

Licea pygmaea (Meyl.) Ing

Studied material: On *Pinus pseudostrobus*, Varela-García 271, 322, 324, 337, 343, 349, 351, 434, 438, 473, 487, 522, 576, 697, 722, 725. On *Abies religiosa*, Varela-García 333, 353, 481, 597, 702, 703, 727.

The 11-14 µm diam. spores with thick warts distributed irregularly and the reduced sporocarps (0.2-0.5 mm) have inclined us towards this taxon, considered by some authors (Martin & Alexopoulos, 1969) to be a variety of *L. pusilla* Schrad. It shows a tendency to conifers since it appeared abundantly on the bark of the three species studied. Previously, Rodríguez-Palma (1998) had described it for Tlaxcala. This is the second record of this species for Mexico.

Licea scyphoides T. E. Brooks & H. W. Keller

Studied material: On *Quercus crassipes,* Varela-García 489, 490, 523, 524, 525, 688. On *Pinus pseudostrobus,* Varela-García 448, 492.

The sporocarps of the studied material were found dispersed on the substrate, they measured 80-100 μm diam., and had short, thick stalks, 250-260 μm in length and 170-180 μm wide, dark and completely filled with a granular material (fig. 3A). The peridium was single, membranous, persistent in maturity forming a cup of grayish yellow (3C3) or pale yellow (4A3) color by transmitted light, with abundant granular material especially at the poles; its internal surface is densely ornamented with warts and dehiscence is circumscissile. Spores in mass appeared olivaceous yellow; spores were yellowish white (1A2) by transmitted light, free, globose, from 11-12 μm diam., smooth with a thinner region of 25-50% of the wall in optical section (fig. 3B).

This species developed abundantly on *Quercus crassipes* and was found only twice on *Pinus pseudostrobus.* According to Keller & Brooks (1977), the refuse material from the peridium concentrates towards the basal and superior portion of the sportheca and is scarce around the lateral walls, which are shiny; in the Mexican specimens, the material seemed to be distributed homogenously over all the peridial surface, but when they were mounted, the granular material was localized clearly at the poles of the sportheca. In our case, the stalks presented a greater length and thickness than those reported by Keller & Brooks (1977) for the type material (which was 250-260 x 170-180 μm vs. 70-170 x 34-60 (-98) μm).

This is the first report of this species for Mexico. Ing & Haynes (1999) reported it from Belize.

Paradiacheopsis fimbriata (G. Lister & Cran) Hertel

Studied material: On *Pinus pseudostrobus,* Varela-García 283, 311, 408, 449, 451, 479, 698.

We found only one or two sporocarps per collection which were almost always in a bad state, yet distinguishable because of the fine capillitium, which ramified scarcely and had expanded tips. It had been recorded previously by Braun & Keller (1986) in the State of Veracruz as *Comatricha fimbriata* G. Lister & Cran.

Perichaena corticalis (Batsch.) Rostaf.

Studied material: On *Quercus crassipes,* Varela-García 424, 425.

Previously recorded by Galindo-Flores (1993) in the State of Tlaxcala.

Perichaena depressa Lib.

Studied material: On *Abies religiosa* , Varela-García 724.

Recorded previously in Mexico on *Taxodium mucronatum* and *Juniperus* sp. bark (Keller & Braun, 1977). This species is not exclusively corticolous and is distributed throughout the country, from Baja California to the Yucatan Peninsula (Illana *et al.,*2000).

Physarum decipiens Curtis

Studied material: On *Juniperus deppeana,* Varela-García 355, 440, 675.

The sporophores were sessile, globose with 0.5-0.9 µm diam. and 0.3-0.5 x 0.9-1.1 mm in length; yellow (2A6 to 2A7), covered with prominent calcareous scales, rounded or elongated, yellow (2A6 to 2A7); the peridium was membranous, pale yellow by transmitted light. The capillitium was reticulate and was formed by very fine hyaline tubes with prominent white nodules, globose or irregular; spores were black in mass, brown or olivaceous by transmitted light with a paler portion covering 25% of its surface in optical section, spiny, globose, 11-12 µm diam.

This is the first record of this species for Mexico. Illana *et al.*(2000) mention unpublished material in Baja California under the name *P. auriscalpium* Cooke which could correspond to this species.

P. didermoides (Pers.) Rostaf.

Studied material: On *Abies religiosa,* Varela-García 467.

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MYCOLOGICAL CHARACTERIZATION OF AN HAPLUDAND SOIL SERIES UNDER THREE MANAGEMENT PRACTICES

by

EDUARDO VALENZUELA F[1], DANTE PINOCHET T[2] AND PERLA CARIAS M[1]

[1]Instituto de Microbiología, Facultad de Ciencias, Universidad Austral de Chile. Casilla 167. Valdivia-Chile. E-mail: evalenzu@uach.cl.

[2]Instituto de Ingeniería Agraria y Suelos, Facultad de Ciencias Agrarias, Universidad Austral de Chile. Casilla 567. Valdivia-Chile. E-mail: dpinoche@uach.cl.

SUMMARY

A taxonomic study of the fungi present in a Hapludand, Pelchuquín soil series in Valdivia was undertaken with the aim of increasing the knowledge of fungal populations on soils derived from volcanic ashes (known locally as "trumaos"). The objective was to determine the influence of three management practices (secondary native forest, permanent pasture and rotational pasture), the timing of soil sampling, soil sample depth and the effect of soil chemical parameters on fungal population diversity. The soil samples were collected in each of the three sectors during autumn (first sampling) and summer (second sampling) from 0-20 cm and 20-40 cm depths. Each soil sample was processed by dilution and soil particle washing methods to isolate the fungi. The chemical parameters (pH, P, total N, organic matter content and interchangeable bases) were determined by routine soil analyses. The largest number of taxa (28) was isolated during the first sampling from the permanent pasture management from 0-20 cm and the smallest number (11) during the second sampling from the secondary native forest management from 20-40 cm. The fungal species *Absidia cylindrospora*, *Clonostachys rosea*, *Fusarium oxysporum*, *Mortierella vinacea*, *Myrothecium roridum* and *Trichoderma koningii* were found in the soil of all three sectors and at both sampling times. *Cunninghamella bainieri*, *Mariannaea elegans*, *Penicillium montanense*, *Trichocladium opacum* and *Westerdykella multispora* are reported for the first time in Chile. The values of the chemical parameters measured were inside the ranges indicated for agricultural soils of the Valdivia county. Some variations were detected on the organic matter content, C:N ratio and available P, which could be due to the different soil management practices. When correlated with the chemical parameters, the largest populations and number of species were found in the soil samples at 0-20 cm and were not influenced by the sampling time or soil management. The largest values for total N and organic matter content were also found at this depth.

Key words: fungi, Volcanic soils, native forest, pasture, Chile.

See Errata

INTRODUCTION

In Chile, research on soil microbiology is scarce and mainly related to the study of some soils derived from volcanic and granitic materials. Zunino et al. (1982) noted that the volcanic soils between Los Angeles and Puerto Montt were characterized by a high incidence of fungi and actinomycetes, in particular the genus *Aspergillus* and *Penicillium*. Borie et al. (1990) working on volcanic soils with different age and degree of evolution, determined the main groups of soil microorganisms and their quantitative distribution. They indicated that the proportion of fungi, actinomycetes and bacteria in “trumaos” soils (mainly Hapludands) was 1:10:20, in “rojo arcillosos” (mainly Haplumults) 1:10:15 and in “ñadis” soils (mainly Plaquands) 1:6:7. Franz (1971) established that the activity of the fungi increased during winter, when the soil humidity is higher and the soil pH becomes more acidic, and also established that the fungal populations varied according to the climatic zone in Chile. *Aspergillus* is the dominant genus in regions with dry summers, but it is absent in the more humid summer southern zones of the country, where different *Mucorales* such as *Circinella simplex* and *Zygorrhinchus heterogamus* are more abundant. After studying the fungal communities of “trumaos” soils southern Chile, Grinbergs (1976) noted that the most abundant fungi isolated were *Moniliales* and the least abundant *Melancoliales*. Lastly, Piontelli & Grixiolli (1993) studied the fungi of subtropical Chilean soils associated with senescent grasses and determined that the most dominant and diverse species were the *Hyphomycetes*.

With the aim of increasing the knowledge of the fungal population on “trumaos” soils, we carried out a taxonomic study of the fungi present in a Hapludand, Pelchuquín soil series of Valdivia. The objective was to determine the influence of three management practices (secondary native forest, permanent pasture and rotational pasture), collection timing of soil samples, depth of soil samples and soil chemical parameters on the fungal population diversity.

MATERIALS AND METHODS

Study area: The soil used in this study was in the commune of Mariquina (562.5 N 673.4 E. System UTM), Valdivia, Chile. It is part of the Pelchuquín soil series (Besoain, 1985) and it is a deep soil with good drainage, a high P fixation capacity and low levels of exchangeable bases (Weinberger, 1971). The sampling site was divided into three small areas and each one subjected to the following management practices:

- A secondary native forest from 1926, with the largest number of vegetable species (61), a prevalence of *Nothofagus obliqua* (oak) and *Laurelia sempervirens* (laurel), no legumes and some graminaceous pastures (Ramirez & San Martin, 1994). This soil was considered as a control because there was seldom any human intervention.
- A permanent pasture from 1955, and subject to rotational grazing with cows. It is composed of a mixture of species from European origin belonging to the Hypero-Agrostidetum capillariae association. It consists of 26 species, a high proportion of which are legumes.
- A rotational pasture from 1872, with the smallest number of vegetable species (21), all from species of European origin and belonging to the Hypero-Agrostidetum capillariae association. It is composed of graminaceous species with a moderate proportion of legumes.

Collection of soil samples: the soil samples were collected in each of the small areas during autumn (first sampling) and summer (second sampling). In each small area, three 50 x 50 cm plots were marked out and three 500 g soil samples at 0-20 cm and 20-40 cm were taken. The samples were transported to the Universidad Austral de Chile, Instituto de Microbiología, for the isolation and taxonomy of the fungi and the Instituto de Ingenieria Agraria y Suelos for their chemical analyses.

Isolation of fungi: the soil samples from each small area, and corresponding to each of the soil depths, were processed independently. The roots, leaves, stones and other foreign materials were aseptically separated. Then, the soil samples were sieved through a 0.5 mm sieve. Five 10 g subsamples were processed using the dilution method of Pochon & Tardieux (1965) and the soil particle washing method of Grinbergs (1976). Each sample was cultivated independently in Petri dishes containing 2% malt extract agar (MEA), penicillin (0.6 mg mL^{-1}) and streptomycin (1 mg mL^{-1}). The cultures were incubated at 23 °C for 10 days and the fungal colonies replicated daily in Petri dishes with 2% MEA. For macro and microscopic analyses, 0.3 cm diameter agar discs of mycelium were cut with a punch from the colonies growing on 2% MEA. They were cultured in triplicate on Petri dishes containing 2% MEA, Potato dextrose agar (PDA) and Czapex agar (CzA) at 23 °C for 14 days. To characterise the mycelial strain morphologically, microscopic samples of fresh mycelium from different parts of the colony were placed in distilled water and examined. The morphology of the colonies was determined according to Stalpers (1978). The macro and microscopic characteristics observed were compared with the identification keys of Arx (1981) to establish the genera to which each of the strains belonged. Several monographs, such as Rifai (1969) for *Trichoderma*, Ramírez (1982) for *Penicillium*, Raper & Fennell (1965) for *Aspergillus*, Samson (1974) for *Paecilomyces*, Sutton (1980) for *Coelomycetes*, Ellis (1971, 1976) for *Hyphomycetes* dematiaceous and Zycha et al. (1969) for *Mucorales,* were used to determine the species.

Chemical analysis of the soil samples: the pH in the water (1:2.5 soil solution ratio), pH in $CaCl_2$ (1:2.5 soil solution ratio), total content of interchangeable bases (Ca, Mg, Na and K) and available P (Olsen method) were determined by the methods described by Sadzawka (1990). Total N by the Kjeldhal method and the soil organic matter content by wet digestion as described by Sadzawka (1990).

RESULTS AND DISCUSSION

The chemical results of Hapludand soils samples taken at 0-20 and 20-40 cm for the first and second sampling times are presented in Table 1.

Table 1. Soil chemical parameters of an Hapludand from Valdivia County.

	Soil samples											
	native forest				Permanent pasture				Rotational pasture			
Analysis	I		II		I		II		I		II	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
pH water (1:2.5)	4.8	5.1	5.0	5.1	5.4	5.4	5.6	5.7	5.8	6.0	5.8	5.8
pH $CaCl_2$ 0.01M	4.4	4.7	4.2	4.6	5.1	5.0	5.1	5.3	5.3	5.5	5.3	5.4
cations												
Ca ($cmol_+$/kg)	1.0	0.2	1.1	0.5	3.2	0.8	3.3	0.8	3.9	2.2	3.9	2.6
Mg ($cmol_+$/kg)	1.6	0.1	1.5	0.3	1.0	0.2	0.8	0.2	0.6	0.3	0.4	0.3
Na ($cmol_+$/kg)	0.3	0.2	0.3	0.2	0.5	0.3	0.7	0.6	0.5	0.4	0.5	0.4
K ($cmol_+$/kg)	0.4	0.1	0.5	0.2	0.8	0.1	0.5	0.1	0.2	0.1	0.5	0.1
T.E.B	3.3	0.6	3.4	1.2	5.5	1.4	5.2	1.6	5.2	2.9	5.3	3.4
P (mg/kg)	5.3	3.0	9.4	3.0	8.7	3.6	12	2.9	16	5.0	15	4.2
N (g/100g)	0.5	0.4	0.6	0.3	0.7	0.4	0.7	0.4	0.5	0.3	0.5	0.2
O.M(g/100g)	16	6.6	20	8.8	16	12	19	11	15	7.7	13	6.3
C:N ration	18	9.6	20	16	14	17	16	17	16	17	16	16

I = first sampling time (autumn), II = second sampling time (summer), X = 0-20 cm depth, Y = 20-40 cm depth, T.E.B = Total exchangeable bases, O.M = Organic matter.

The values of the chemical parameters measured were inside the ranges indicated by Pinochet (1991) for agricultural soils in the Valdivia county. Some variations in chemical parameters were detected in the organic matter content, C:N ratio and available P, which could be due to the different soil management practices. In Table 1, it was observed that the lowest pH (4.8 in water and 4.4 in $CaCl_2$) was found in the native forest soil collected at 0-20 cm irrespective of the sampling time. The highest values of P, total N and organic matter were determined in the samples at 0-20 cm irrespective of the soil management practice and the sampling time. The highest value of available P (16 mg /kg^{-1}) was measured in the samples from rotational pasture, the highest total N (0.7%) in permanent pasture and the highest organic matter content (20%) in the samples from the secondary native forest. The largest C:N ratio (20) was found in the soil samples from the secondary native forest at 0-20 cm. These results agree with those of the Instituto de Investigaciones Agropecuarias (1985) because in most of the Chilean volcanic soils the largest percentages of total N and organic matter are found in the first 20 cm.

The first column in Table 2 shows the fungal taxa isolated during the first sampling (autumn) and the second to seventh column indicate the presence or absence of fungi according to the management practice and soil sampling depth. The presence or absence was due to both methods of isolation (dilutions and soil particle washing). In Table 3, the same parameters are shown, but for the second sampling time (summer).

Table 2. Fungal taxa isolated from Hapludand soils from Valdivia County during the first sampling(autumn).

	Management practice					
	A		B		C	
	Depth (cm.)		Depth (cm.)		Depth (cm.)	
Taxa	0-20	20-40	0-20	20-40	0-20	20-40
Absidia cylindrospora	+	+	+	+	+	+
Absidia glauca	–	–	–	–	+	–
Absidia spinosa	–	–	–	+	–	–
Acremonium murorum	+	–	–	–	–	–
Alternaria alternata	+	–	+	–	–	–
Aspergillus flavus	–	–	+	–	–	–
Aspergillus niger	+	+	+	+	–	–
Cladosporium cladosporoides	+	+	–	–	–	–
Clonostachys rosea	+	+	+	+	+	+
Chaetomiun funiculum	–	–	+	–	–	–
Exophiala jeanselmei	+	+	+	+	+	+
Fusarium graminearum	–	–	+	+	+	+
Fusarium oxysporum	+	+	+	+	+	+
Geotrichum candidum	+	–	–	–	+	+
Gongronella butlerii	–	–	+	–	–	–
Gonytrichum macrocladium	+	–	+	–	–	–
Humicola grisea	–	–	–	–	+	+
Mariannaea elegans	–	–	–	+	–	–
Mortierella isabellina	+	+	+	–	–	–
Mortierella nana	+	–	+	+	–	–
Mortierella vinacea	+	+	+	+	+	+
Myrothecium roridum	+	+	+	+	+	+
Oidiodendrum griseum	+	–	–	–	–	–
Paecilomyces lilacinus	–	–	+	–	–	–
Penicillium serie brasilianum	–	–	+	–	–	–
Penicillium serie citrinum	–	–	+	–	–	–
Penicillium serie decumbens	–	–	+	+	+	+
Penicillium serie frecuentans	–	–	+	+	+	+
Penicillium serie godlewskii	–	–	–	–	–	+
Penicillium serie implicatum	+	–	–	–	–	–
Penicillium serie janthinellum	–	–	–	+	–	–
Penicillium serie nigricans	–	–	–	+	+	+
Penicillium serie ramigena	+	+	+	+	+	+
Penicillium serie restrictum	+	–	+	+	–	–
Penicillium serie thomii	+	–	–	–	–	–
Phoma destructiva	+	+	–	–	–	–
Pragmopycnis sp.	–	–	+	–	–	–
Scytalidium lignicola	+	+	–	–	–	–
Trichocladium opacum	+	+	+	+	+	+
Trichoderma koningii	+	+	+	+	+	+
Trichoderma pseudokoningii	–	–	+	+	+	+
Verticillium clamydosporium	–	–	+	–	+	–
Westerdykella multispora	–	–	+	–	–	–
Xanthothecium peruvianum	+	–	–	–	–	–
Total	24	14	28	20	18	17

A = Secondary native forest , B = Permanent pasture, C = Rotational pasture.

Table 3. Fungal taxa isolated from Hapludand soils from Valdivia County during the second sampling(summer).

	Management practice					
	A		B		C	
	Depth (cm.)		Depth (cm.)		Depth (cm.)	
Taxa	0-20	20-40	0-20	20-40	0-20	20-40
Absidia cylindrospora	+	+	+	+	+	+
Absidia spinosa	+	+	+	+	+	+
Acremoniun murorum	+	–	–	–	–	–
Aspergillus fischerii	–	–	+	–	–	–
Aspergillus niger	–	–	+	+	+	–
Clonostachys rosea	+	+	+	+	+	+
Cunninghamella bainieri	–	–	+	–	–	–
Chloridium virescens	–	–	+	–	–	–
Eurotium tonophilus	–	–	+	–	–	–
Fusarium graminearum	–	–	+	+	–	–
Fusarium oxysporum	+	+	+	+	+	+
Geotrichum candidum	–	–	+	+	+	+
Gongronella butlerii	–	–	+	–	+	–
Gonytrichum macrocladium	–	–	+	–	–	–
Humicola grisea	+	+	–	–	–	–
Malbranchea pulchella	–	–	–	–	+	–
Melanospora sp.	+	–	–	–	–	–
Micelio esteril	+	+	+	–	–	–
Mortierella isabellina	+	+	–	–	–	–
Mortierella nana	+	–	–	–	–	–
Mortierella vinacea	+	+	+	+	+	+
Mucor hiemalis	–	–	+	–	+	–
Myrothecium roridum	+	+	+	+	+	+
Oidiodendrum griseum	+	–	–	–	–	–
Paecilomyces lilacinus	–	–	+	–	–	–
Penicillium serie decumbens	–	–	+	+	+	+
Penicillium serie godlewskii	–	–	+	–	–	–
Penicillium serie ramigena	–	–	+	–	+	+
Pragmopycnis sp.	–	–	+	–	–	–
Scytalidium lignicola	–	–	–	–	+	–
Sporendonema sp.	–	–	–	+	–	–
Trichoderma harzianum	+	+	–	–	+	+
Trichoderma koningii	+	+	+	+	+	+
Westerdykella multispora	–	–	–	–	+	–
Zygorrhynchus moelleri	–	–	–	–	+	+
Total	15	11	23	12	18	12

A = Secondary native forest , B = Permanent pasture, C = Rotational pasture.

Tables 2 and 3, show that the species *Absidia cylindrospora*, *Clonostachys rosea*, *Fusarium oxysporum*, *Mortierella vinacea*, *Myrothecium roridum* and *Trichoderma koningii* were found in all samples regardless the management practice, sampling time and soil sample depth. These results agree with those obtained by Grinbergs (1976) who, after studying fungal communities of "trumaos" soils south of Chile, determined that most of these soils contained a great variety of *Mucorales*, including *M. vinacea* and *Moniliales* such as *C. rosea*, *F. oxysporum* and *T. koningii*. Franz (1971), studing the distribution of fungi in Chilean soils according to the climatic zone of the country, found *F. oxysporum* and *T. koningii* on "trumaos" soils south of the country.

During the first sampling time, *Exophiala jeanselmei* and *Trichocladium opacum* were found irrespective of the soil management practice and soil sampling depth (Table 2), whereas *Absidia spinosa* was found during the second sampling (Table 3). We consider that *A. cylindrospora*, *A.*

second sampling (Table 3). We consider that *A. cylindrospora*, *A. spinosa*, *C. rosea*, *E. jeanselmei*, *F. oxysporum*, *M. vinacea*, *M. roridum*, *T. koningii* and *T. opacum* should be part of the native fungal flora of the "trumaos" soils, because they have been constantly isolated from this soil type by Franz (1971), Grinbergs (1976) and Mujica & Vergara (1980) and also from vegetable residues deposited over the soils (Mujica & Vergara, 1980; and Leiva, 1999). The absence of *E. jeanselmei* and *T. opacum* during the second sampling and of *A. spinosa* during the first sampling could be due, as indicated by Killham (1994), to climatic factors and/or prevalent chemical-physical parameters of the soil, which are usually in a latent state.

Tables 2 and 3, show that the largest number of taxa were in the 0-20 cm depth irrespective of the sampling time and soil management practice. The largest values for available P, total N and organic matter content were also found in the soil samples at 0-20 cm (Table 1). This would indicate that a higher supply of organic and inorganic materials needed for the nutritional development of the fungi exists within this depth range. Alexander (1980) noted that the bacterial and fungal populations in the soil usually develop in the first 20 cm of soil because nutrients, humidity, temperature and oxygen concentrations are within the range necessary for the growth of these microorganisms. On the other hand, Medina (1967) found the largest diversity and abundance of fungi were found at 0-5 cm on a granitic Chilean soil of the Lo Vásquez soil series under two different management practices. Grinbergs (1976), in a study of fungi in "trumaos soil", also noted that the largest diversity of fungi was isolated in the upper strata of the soils evaluated.

During the first sampling time (Table 2), the largest number of taxa (28) was isolated from the permanent pasture at 0-20 cm and the smallest number (14) from the secondary native forest at 20-40 cm. These results correlate with the chemical parameters present during the first sampling time (Table 1), with the most total N (0.7%) and organic matter (16%) being present in the soil samples from the permanent pasture management at 0-20 cm. Moreover, the C:N ratio was 14. It must be taken into account that the permanent pasture site had a high proportion of leguminous pasture and was under rotational grazing with dairy cows. This is because, as noted by Saddler (1993), other than the physical-chemical characteristics of the soil, it is important to consider the quality of the organic residues decaying in the soil, especially the C:N ratio. C:N ratio of near 10:1 for the vegetable residues allows the microorganisms in the soil to degrade them much more easily because enough energy would exist to carry out the catabolic processes and for the microorganisms to grow. According to Hudson (1968) and Wild (1992), the vegetable residues from leguminous pastures are more tender, contain a higher proportion of organic molecules and their roots and nodules are also rich in nitrogen. In addition, the continuous input of vegetable residues and bovine deposits (faeces and urine) to the soil during permanent pasture management would allow a large population of microorganisms to develop in the soil. These antecedents would explain why the largest number of taxa detected, in terms of variety and quantity, were found in the soil of the permanent pasture management practice.

Observations for the second sampling time were similar to the first sampling time, with the largest taxa number (23) isolated from the permanent pasture at 0-20 cm and the smallest number (11) from the soil of the secondary native forest at 20-40 cm (Table 3). In addition, the chemical parameters evaluated show that the largest total N (0.7%) and second highest organic matter content (19%) were determined in the soil samples of the permanent pasture at 0-20 cm (Table 1). There was also a low C:N ratio of 16. The similarity of the results between the different sampling times confirms the influence of management on the fungal population dynamics of the soil studied.

It could be considered that, at the first and second sampling times, the largest number of fungal taxa should be from the soil samples from the native forest because the soil samples had the smallest pH, good organic matter content and a moderate content of total N (Table 1). However, as observed in Tables 2 and 3, the largest fungal populations were found in the soil samples from the pasture management. This could be due to the difference in the quality and quantity of the vegetable residues deposited over, or into the soil (i.e., leaves, shoots, branches, woody remains and trunks). The vegetable residues from the native forest certainly had higher lignin and cellulose proportions than did those from the pasture management practice. They also had a higher C:N ratio and, because of a constant input of vegetable residues, there was not a large variation in microbial populations. Similar results have been noted in other studies, such as those by Christensen (1969), Bettucci et al. (1993) and Bettucci & Alonso (1995). Franz (1971) detected a similar tendency in Chile, noting that the number of fungal species in soil samples from a native temperate rainforest in Valdivia was smaller compared with 13 soil samples taken from sites with different agriculture-forest management practices. The only exception was for a soil sample collected from a *Pinus radiata* cultivation. Lima et al. (1994) pointed out that the lignin concentration in the leaves of *Nothofagus dombeyi* increases as they decay, which leads to a slow ultimate degradation. Similarly, Leiva (1999) indicated that litter of *N. pumilio* quickly decomposes during the first three months, with a loss of nearly 50% of its dry weight, but then the rate of decay decreases, probably because of the litter's lignin content.

At both sampling times, the dominant fungal taxa were the *Hyphomycetes* (mitosporic fungi) (Tables 2 and 3). This agrees with the research of Grinbergs (1976) for fungi of "trumaos" soil. Among the *Hyphomycetes*, a large variety and quantity of *Penicillium* strains were isolated, which agrees with the results of Zunino et al. (1982), who also isolated species of the genera *Aspergillus* (*A. fischerii*, *A. flavus* and *A. niger*) and also agrees with Piontelli & Grixiolli (1993), but not with Franz (1971) who indicated that in this zone different *Mucorales* prevailed and noted that *Aspergillus* species were absent in the humid zone of south Chile. In the present study, the following *Mucorales* genera *Absidia*, *Cunninghamella*, *Gongronella*, *Mortierella*, *Mucor* and *Zygorrhynchus* were isolated. However, they were not found in large numbers and showed similar behaviour to that indicated by Grinbergs (1976), who noted a large presence of species of the genus *Mortierella*.

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TAXONOMICAL STUDIES ON USTILAGINALES. XXII.

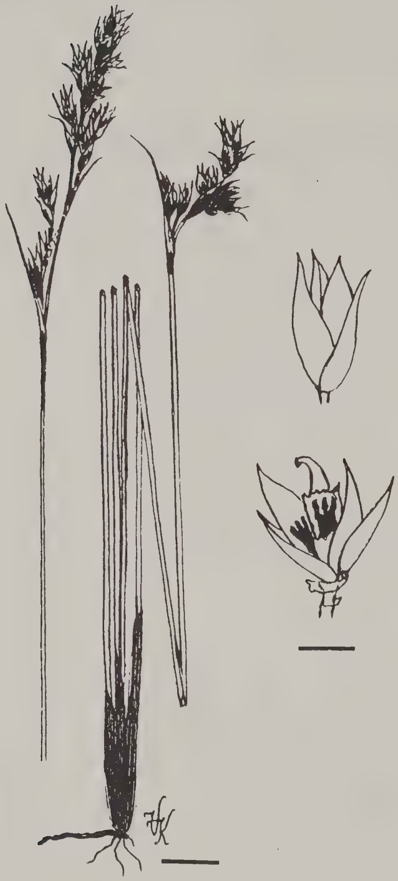
KÁLMÁN VÁNKY

Herbarium Ustilaginales Vánky (HUV)
Gabriel-Biel-Str. 5, D-72076 Tübingen, Germany
e-mail: VANKY.K@cityinfonetz.de

Key words: smut fungi, Ustilaginomycetes, new species, new name, new combinations, synonyms, lectotype.

ABSTRACT

Twenty-five NEW SPECIES of smut fungi are proposed: *Aurantiosporium scleriae*; *Doassansiopsis nymphoides*; *Entyloma aeschynomenis*; *E. coreopsis*; *E. medicaginis*; *Macalpinomyces leptocarydionis*; *M. magicus*; *M. nodiglumis*; *M. pogonarthriae*; *Moreaua elongata*; *Mo. gigaglomerulosa*; *Mo. opaca*; *Sporisorium cenchri-elymoidis*; *S. inopinatum*; *S. megaloprotachnes*; *S. schizachyrii*; *Tilletia aristidae*; *T. mauritiana*; *T. pseudochaetochloae*; *T. robeana*; *T. tanzanica*; *Ustilago dactyloctenii-gigantei*; *U. enteropogonis*; *U. mauritiana*; *U. neurachnis*. NEW NAME proposed: *Sporisorium lingianum*. NEW COMBINATIONS proposed: *Macalpinomyces bursus*; *M. chloridionis*; *M. ovariicolopsis*; *Sporisorium anthephorae*; *S. chaseae*; *S. dubiosum*; *S. mesoseti*; *S. myosuroidis*; *S. paranaense*; *Ustanciosporium kuwanoanum*; *Ustilago suddiana*; *Yelsemia speculariae*. SYNONYMS: *Sphacelotheca inconspicua* is *Sporisorium mesoseti*; *Sorosporium apparaoi* and *Thecaphora africana* represent *Ustanciosporium kuwanoanum*; *Ustilago goyazana* is *Sporisorium chaseae*. LECTOTYPE is designated for *Sphacelotheca chaseae*.



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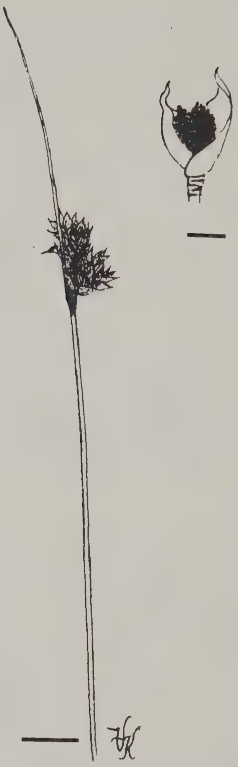

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Fig. 1. Sori of *Moreaua elongata* Vánky in the spikelets of *Baumea tetragona* (Labill.) S. T. Blake (type). Habit and enlarged two infected spikelets, one with partially removed and opened floral envelopes.

Bars = 1 cm for the habit, 2 mm for the detail drawings.

Fig. 2. Sori of *Moreaua gigaglomerulosa* Vánky on *Lepidosperma neesii* Kunth (type). Habit and enlarged a spikelet with most of the floral envelopes removed showing the black, agglutinated spore balls on the surface of inner floral organs. Bars = 1 cm for the habit, 1 mm for the detail drawing.

A NEW SMUT FUNGUS OF *BAUMEA* (CYPERACEAE)

Cunningham (1926:77) described *Tolyposporium littorale* G. Cunn. on *Cladium huttonii* Kirk. (= *Baumea arthrophylla* (Nees) Boeckeler) in New Zealand. The fungus was transferred into the genus *Moreaua* (Vánky, 2000b:352). A different smut fungus was found in DAR on *Baumea tetragona*:

Moreaua elongata Vánky, **sp. nov.**

Typus in matrice *Baumea tetragona* (Labill.) S. T. Blake (det. K. Vánky), Australia, New South Wales, Mystery Bay, Headland, 20.IV.1974, leg. D. F. Blaxell 1337 & L. A. S. Johnson. Holotypus in DAR 56609, isotypus in NSW et in Herbario Ustil. Vánky, HUV 19450.

Sori in floribus aliquantulum tumefactis, involucris floralibus perfecte obtecti, massam glomerulorum sporarum nigram, agglutinatam usque granuloso-pulveream in superficie organorum intimorum floralium (filamenta, gynoeceum) formantes. *Glomeruli sporarum* forma et magnitudine varii, subglobosi, ellipsoidales, elongati usque irregulares, 40–130 x 50–150(–190) µm, rubrobrunnei, e sporis multis, pressu faciliter separabilibus compositi. *Sporae* in visu surficiali variae, polyangulariter irregulares, 5–10,5 x 5,5–15 µm, in visu laterali elongatae, raro subtriangulares, 15–40 µm longae; pariete superficiei liberae 1–1,5 µm crasso, verrucis irregularibus disjuncte dispositis, pariete laterum tangentium tenui, cca. 0,5 µm, levi.

Sori (Fig. 1) in somewhat swollen flowers, completely hidden by floral envelopes, forming black, agglutinated to granular-powdery mass of spore balls on the surface of the innermost floral organs (filaments, gynoeceum). *Spore balls* (Figs. 5, 6) variable in shape and size, subglobose, ellipsoidal, elongated to irregular, 40–130 x 50–150(–190) µm, reddish-brown, composed of many spores which separate easily by pressure. *Spores* (Figs. 5, 6) in surface view variable, polyangularly irregular, 5–10.5 x 5.5–15 µm, in lateral view elongated, rarely subtriangular, 15–40 µm long; wall of the free surface 1–1.5 µm thick, provided with sparsely situated, irregular warts; wall of the contact sides thin, c. 0.5 µm, smooth.

On Cyperaceae: *Baumea tetragona* (Labill.) S. T. Blake; Australia. Known only from the type collection.

Moreaua elongata differs from *M. littoralis* (G. Cunn.) Vánky especially in the size of the spore balls and spores and in the thickness of the spore wall. In *M. littoralis* the length of the spore balls is 40–100 µm, that of the spores 13–25 µm, the wall of the free surface of the spores is 3–6(–8) µm thick. A further *Moreaua* species, possessing 20–40 µm long spores is *M. evandrae* (Websdane & Vánky) Vánky (type on *Evandra aristata* R. Br.). However, in *M. evandrae* the spore balls are larger (80–160 x 90–210 µm), the spores are firmly, inseparably united in the balls, the free wall of the spores is 2.5–5 µm thick with a germ pore.

Etymology: *elongata* (from the Latin elongatus, -a, -um = elongated), referring to the shape of the spores.

A NEW SMUT FUNGUS OF *LEPIDOSPERMA* (CYPERACEAE)

I revised (Vánky, 1997c:145-149) the smut fungi of *Lepidosperma* and recognised four species: *Heterotolyposporium lepidospermae* Vánky, *Tolyposporium lepidospermae* McAlpine, *T. rodwayi* McAlpine, and *T. megaglomerulosum* Vánky. Later, all species of *Tolyposporium* on Cyperaceae have been transferred into the genus *Moreaua* Liou & H. C. Cheng (Vánky, 2000b). The three *Moreaua* species of *Lepidosperma* differ especially in the spore ball measurements, in the number of spores in a ball, and in the colour of the spores and spore balls. The length of the spore balls in *M. lepidospermae* is 25–60 µm, in *M. rodwayi* 35–110 µm and in *M. megaglomerulosa* 60–160 µm. Checking unidentified smut fungi in DAR, a specimen showed larger and paler spore balls than those of *M. megaglomerulosa*. It is considered a different species:

Moreaua gigaglomerulosa Vánky, **sp. nov.**

Typus in matrice *Lepidosperma neesii* Kunth, Australia, New South Wales, Sydney, Centennial Park, I.1897, leg. W. Forsyth. Holotypus in DAR 38010, isotypus in HUV 19566.

Sori illis specierum ceterarum generis *Moreaua* in matrice *Lepidosperma* congruentes, in superficie organorum internorum floralium massam nigram, primo agglutinatam, serius granuloso-pulveream glomerulorum sporarum, indumentis floralibus perfecte absconditam formantes. Glomeruli sporarum plus-minus irregulares, elongati, rarius subglobosi vel ellipsoidales, nonnunquam glomeruli 2 vel 3 confluentes (magnitudo eorum hic non significata), (50–)60–140 x 60–220 µm, atro-rufobrunnei, non opaci, e sporis pluries decem usque pluribus centum, firmiter unitis compositi. *Sporae* subcuneiformes, radialiter elongatae, in visu surficiali polyangulariter irregulares, 5–10 x 7–13 µm, in visu mediano opticali 13–32(–36) µm longae, flavidobrunneae; pariete in superficie libera 1,5–3 µm crasso, moderate dense, irregulariter verruculoso, excepto poro germinativo 2,5–3 µm lato, rotundo, colore pallidiore; pariete in lateribus contactis tenuiore, cca. 0,5 µm, levi.

Sori (Fig. 2) as in other *Moreaua* species of *Lepidosperma*, on the surface of internal floral organs forming a black, first agglutinated, later granular-powdery mass of spore balls, completely hidden by the floral envelopes. *Spore balls* (Figs. 7, 8) more or less irregular, elongated, more rarely subglobose or ellipsoidal, sometimes two or three balls confluent (measurements of which are not considered), (50–)60–140 x 60–220 µm, dark reddish-brown, not opaque, composed of tens to hundreds of firmly united spores. *Spores* (Figs. 7, 8) subcuneiform, radially elongated, in surface view polyangularly irregular, 5–10 x 7–13 µm, in optical median view 13–32(–36) µm long, yellowish-brown; wall of the free surface 1.5–3 µm thick, moderately densely, irregularly verruculose, except a 2.5–3 µm wide, rounded, lighter coloured germ pore; wall of the contact sides thinner, c. 0.5 µm, smooth.

On Cyperaceae: *Lepidosperma neesii* Kunth; Australia. Known only from the type collection.

Species of *Moreaua* on *Lepidosperma* are not host species specific. The same fungus may parasitise different *Lepidosperma* species, and the same *Lepidosperma* species may be parasitised by different species of *Moreaua.*

A NEW SMUT FUNGUS OF *TETRARIA* (CYPERACEAE)

On *Tetraria* a single smut fungus is known, *Moreaua tetrariae* (Vánky) Vánky (type on *T. capillaris*, Australia). A different species was found in the Herb. DAR:

Moreaua opaca Vánky, **sp. nov.**

Typus in matrice *Tetraria capillaris* (F. Muell.) J. M. Black, Australia, New South Wales, Mount Darragh, near Bombala on Cann River road, 22.VIII.1963, leg. E. F. Constable 4426. Holotypus in DAR 75416, isotypus in Herbario Ustil. Vánky, HUV 19590.

Moreaua opaca a *M. tetrariae* (Vánky) Vánky (nomen basale *Tolyposporium tetrariae* Vánky, Mycotaxon 62:160, 1997b, typus ad *Tetraria capillaris*, Australia) distincta glomerulis sporarum atrioribus et minoribus. Illi speciei novae *M. opacae* nigrobrunnei, opaci et 20–45 x 25–55(–60) µm, sed glomeruli sporarum *M. tetrariae* atro-rufobrunneae, 30–65(–80) x 35–90(–105) µm.

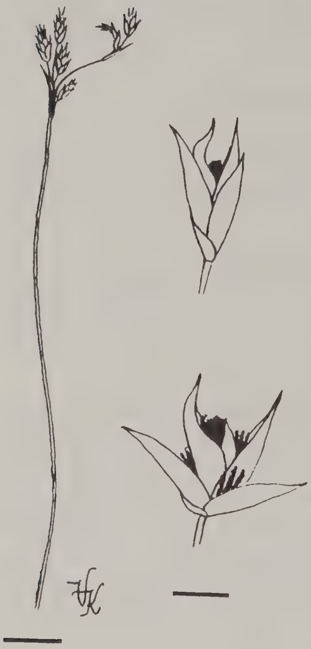
Moreaua opaca differs from *M. tetrariae* (Vánky) Vánky in having darker and smaller spore balls. These in *M. tetrariae* are dark reddish-brown measuring 30–65(–80) x 35–90(–105) µm.

Sori (Fig. 3) in the swollen spikelets, filled with a black, granular powdery mass of spore balls, produced on the surface of the innermost floral organs, completely hidden by the floral envelopes. *Spore balls* (Figs. 9, 10) subglobose, ovoid, ellipsoidal, elongated to irregular, 20–45 x 25–55(–60) µm, blackish-brown, opaque, permanent, composed of numerous spores which cannot be counted or measured because of the black colour of the balls.

On Cyperaceae: *Tetraria capillaris* (F. Muell.) J. M. Black; Australia. Known only from the type collection.

A NEW *TILLETIA* OF *POLYPOGON* (GRAMINEAE)

Polypogon Desf., with 18 species in warm temperate regions of the world, and on tropical mountains, belongs to the subfamily Pooideae, tribe Aveneae, subtribe Alopecurinae (Clayton & Renvoize, 1986:139). Two smut fungi are known on *Polypogon*: *Jamesdicksonia dactylidis* (Pass.) R. Bauer, Begerow, A. Nagler & Oberw., producing dark leaf spots on a great number of grass genera, and *Tilletia polypogonis* Vánky & N. D. Sharma, in the ovaries of *Polypogon monspeliensis* (L.) Desf. in India. Between unidentified specimens in DAR a different *Tilletia* species was discovered:



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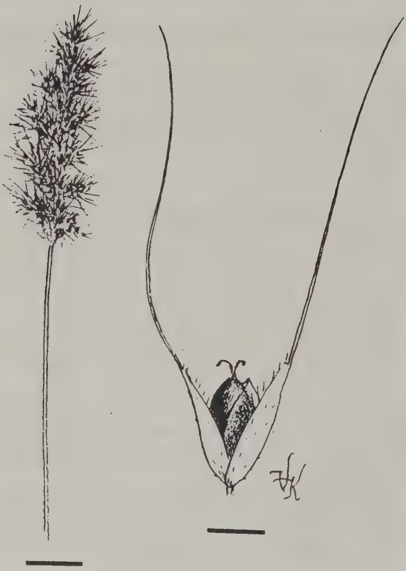

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Fig. 3. Sori of *Moreaua opaca* Vánky in the spikelets of *Tetraria capillaris* (F. Muell.) J. M. Black (type). Habit and enlarged two spikelets, one with opened floral envelopes, showing the black masses of spore balls on the surface of the filaments and gynoeceum.

Bars = 1 cm for the habit, 2 mm for the detail drawings.

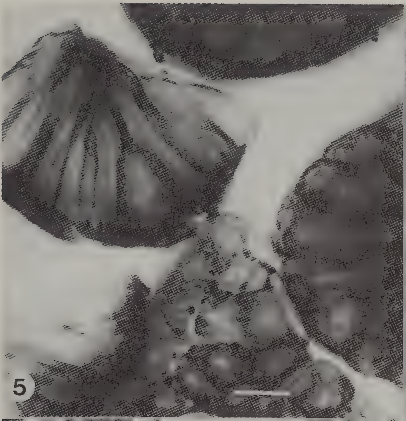
Fig. 4. Sori of *Tilletia robeana* Vánky in the ovaries of *Polypogon monspeliensis* (L.) Desf. (type). Habit and enlarged a spikelet with a sorus.

Bars = 1 cm for the habit, 1 mm for the detail drawing.

Figs. 5, 6. Spore balls and spores of *Moreaua elongata* Vánky on *Baumea tetragona* (Labill.) S. T. Blake, in LM and in SEM (type). Note the form and size of the spores in squashed spore balls.

Figs. 7, 8. Spore balls and spores of *Moreaua gigaglomerulosa* Vánky on *Lepidosperma neesii* Kunth, in LM and in SEM (type).

Figs. 9, 10. Spore balls and spores of *Moreaua opaca* Vánky on *Tetraria capillaris* (F. Muell.) J. M. Black, in LM and in SEM (type). Bars = 10 µm.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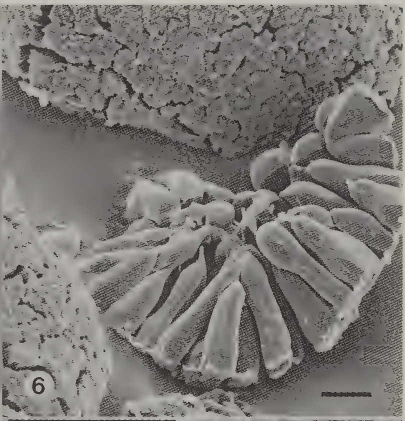
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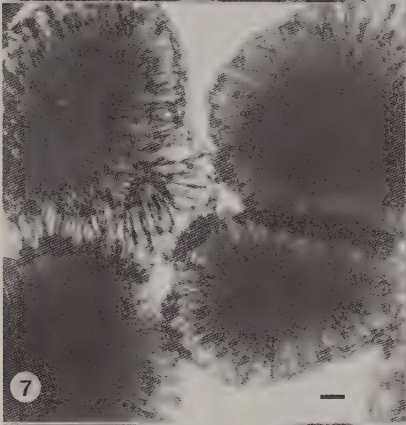
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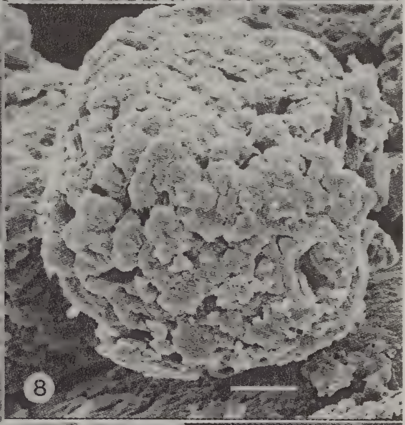
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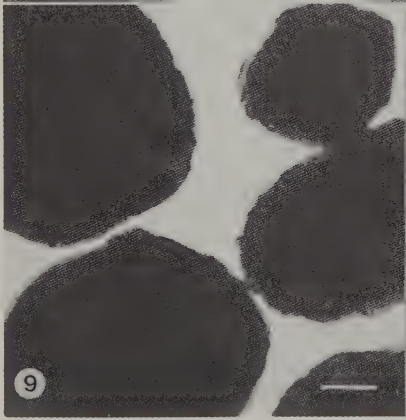
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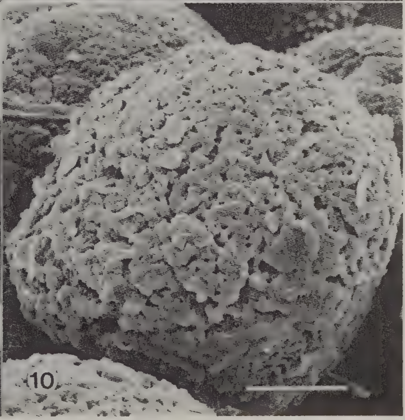
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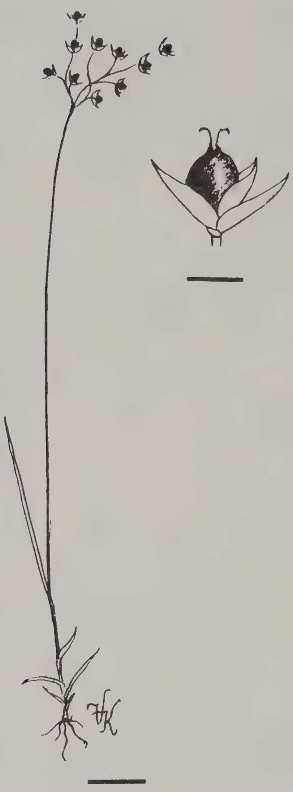

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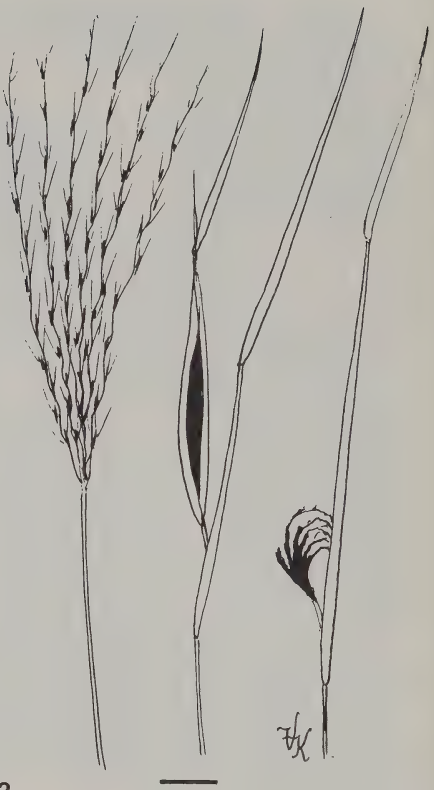

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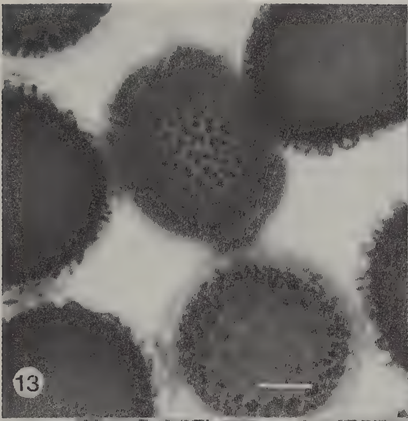
Fig. 11. Sori of *Tilletia mauritiana* Vánky in the ovaries of *Brachiaria umbellata* (Trin.) W. D. Clayton (type). Habit and enlarged a sorus.
Bars = 1 cm for the habit, 1 mm for the detail drawing.

Fig. 12. Sori of *Ustilago enteropogonis* Vánky in the inflorescence of *Enteropogon ramosus* B. K. Simon (type). To the left a healthy inflorescence.
Bar = 1 cm.

Figs. 13, 14. Spores and sterile cells of *Tilletia robeana* Vánky on *Polypogon monspeliensis* (L.) Desf., in LM and in SEM (type).

Figs. 15, 16. Spores and sterile cells of *Tilletia mauritiana* Vánky on *Brachiaria umbellata* (Trin.) W. D. Clayton, in LM and in SEM (type).

Figs. 17, 18. Spores of *Ustilago enteropogonis* Vánky on *Enteropogon ramosus* B. K. Simon, in LM and in SEM (type). Bars = 10 µm.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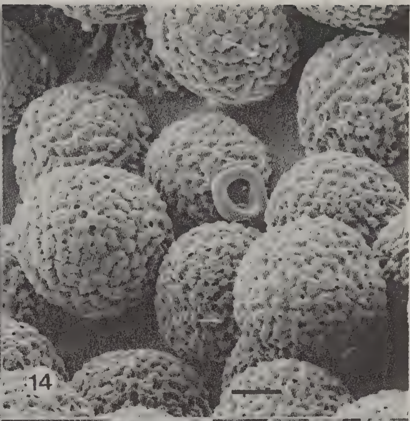
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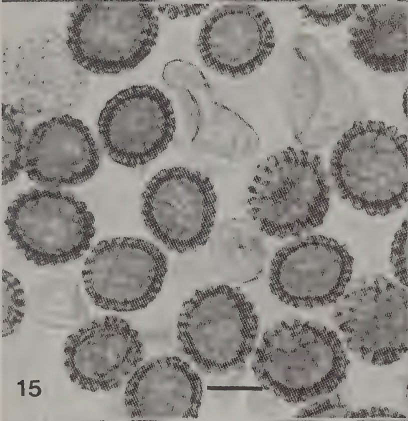
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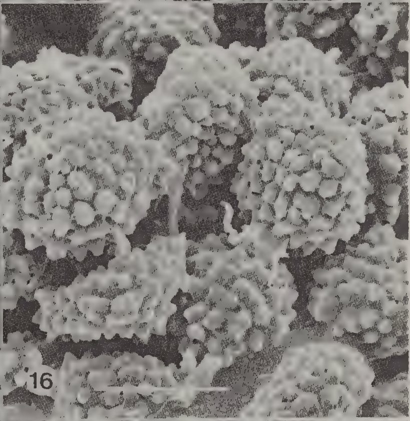
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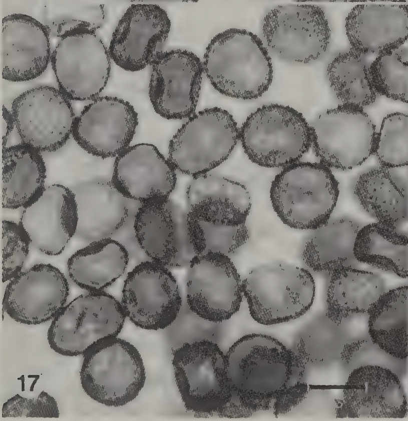
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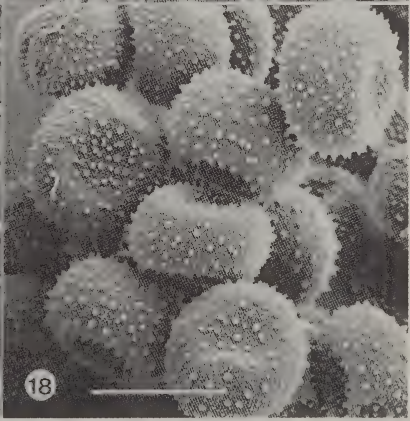
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Tilletia robeana Vánky, sp. nov.

Typus in matrice *Polypogon monspeliensis* (L.) Desf., Australia, South Australia, cca. 250 km SSE Adelaide, Robe, 37°13' S, 139°46' E, 6.I.1992, leg. T. Bertozzi. Holotypus in DAR 68440, isotypus in HUV 19585. Paratypus ibidem, leg. C. Wilmshurst, DAR 68577.

Sori in ovariis omnibus eiusdem inflorescentiae, ellipsoidales vel limoniiformes, 0,5–0,8 x 0,5–1 mm, involucris floralibus absconditi et pericarpio brunneo cooperti, quo maturitate rupto massam nigram, pulveream sporarum cellulis sterilibus intermixtam ostendentes. *Sporae* globosae, subglobosae, ovoideae usque late ellipsoidales, 30–40 x 36–44 μm, mediocriter usque atro-rufobrunneae, cum verrucis 2,5–4 μm altis, obtusis, in visu superficiali sicut areae fuscae dense dispositae, irregulariter polyedricae, per diametrum sporae 10–16, apparentibus. *Cellulae steriles* forma et magnitudine variae, subglobosae, ovoideae, ellipsoidales usque irregulares, cum lateribus deplanatis, 10–21 x 12–25(–30) μm, subhyalinae usque pallide flavae; pariete 1,5–2,5(–3) μm crasso, levi.

Sori (Fig. 4) in all ovaries of an inflorescence, ellipsoidal or lemon-shaped, 0.5–0.8 x 0.5–1 mm, hidden by the floral envelopes and covered by the brown pericarp which ruptures at maturity disclosing the black, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 13, 14) globose, subglobose, ovoid to broadly ellipsoidal, 30–40 x 36–44 μm, medium to dark reddish-brown, provided with 2.5–4 μm high, blunt warts, in surface view showing as densely situated, irregularly polyhedral, dark areas, 10–16 per spore diameter. *Sterile cells* (Figs. 13, 14) variable in shape and size, subglobose, ovoid, ellipsoidal to irregular with flattened sides, 10–21 x 12–25(–30) μm, subhyaline to pale yellow; wall 1.5–2.5(–3) μm thick, smooth.

On Gramineae: *Polypogon monspeliensis* (L.) Desf.; Australia. Known only from two collections from the same place in Australia.

Etymology: *robeana* from Robe, the place were this smut was collected.

Tilletia robeana differs from *T. polypogonis* in which the spores are 18.5–23 μm long, light yellow to pale yellowish-brown and are irregularly and incompletely reticulate (comp. Vánky, 1994b:168). *Tilletia robeana* differs also from the similar *T. paradoxa* Jacz. (type on *Phleum* sp.) in which the spores measure 37–52 x 37–58 μm and the warts are 4–6 μm high.

A NEW *TILLETIA* SPECIES ON *BRACHIARIA* (GRAMINEAE)

On *Brachiaria* only one *Tilletia* species is known, *T. brachiariae* (Pavgi & Thirum.) Vánky, type on *B. distachya* Stapf, India (comp. also Vánky, 1997c:138-141). A different *T.* species was discovered on *B. umbellata* collected in Mauritius and preserved in IMI as *Ustilago* sp.

Tilletia mauritiana Vánky, sp. nov.

Typus in matrice *Brachiaria umbellata* (Trin.) W. D. Clayton (conf. C. E. Hubbard), Mauritius, sine loco et die, leg. P. O. Wiehe (D 134), comm. 22.II.1939. Holotypus in IMI 42344, isotypus in HUV 19021.

Sori in ovariis, omnia in eadem inflorescentia inficientes, globoidei, cum apice brevi, acuto, diametro cca. 1 mm, involucris floralibus partim absconditi, membrana brunnea, sparse hispida, origine matricali (pericarpio) obtecti, qua irregulariter rupta massam brunneam, pulveream sporarum cum cellulis sterilibus intermixtam ostendentes. *Sporae* globosae, subglobosae, plerumque late ellipsoidales, 11–16 x 13,5–18,5 μm, pallide flavidobrunneae, verrucis asperis, obtusis, subconicis, raro complanatis, 1,5–2,5 μm altis, 1–1,5(–2) μm latis ad basin earum, in visu superficiali sicut areis irregulariter polygonalibus dense dispositis, atris, 6–12 per diametrum sporae apparentibus instructae. "Sporae immaturae" communes, magnitudine variae, usque 22 μm longae, subhyalinae usque pallide flavae, sparse punctatae usque verrucosae, plerumque collapsae. *Cellulae steriles* paucae, subglobosae usque ellipsoidales, 12–20 μm longae, hyalinae; pariete 2,5–4 μm crasso, levi, in speciminibus vetustis collapso.

Sori (Fig. 11) in ovaries, infecting all ovaries in an inflorescence, globoid with a short, acute tip, c. 1 mm in diameter, partly hidden by the floral envelopes, covered by a brown, sparsely hispid membrane of host origin (pericarp) which ruptures irregularly disclosing the brown, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 15, 16) globose, subglobose, usually broadly ellipsoidal, 11–16 x 13.5–18.5 μm, pale yellowish-brown, provided with coarse, blunt, subconical, rarely flattened warts, 1.5–2.5 μm high, 1–1.5(–2) μm wide at their base, in surface view appearing as closely situated, darker, irregularly polygonal areas, 6–12 per spore diameter. "Immature spores" common, variable in size, up to 22 μm long, subhyaline to pale yellow, sparsely punctate to verrucose, usually collapsed. *Sterile cells* (Figs. 15, 16) few, subglobose to ellipsoidal, 12–20 μm long, hyaline; wall 2.5–4 μm thick, smooth, collapsed in old specimen.

On Gramineae: *Brachiaria umbellata* (Trin.) W. D. Clayton (*Panicum umbellatum* Trin.; *Panicum nossibense* Steud.); Mauritius. Known only from the type collection.

Tilletia mauritiana differs from *T. brachiariae*, in which the spores are 19–24(–26) μm long, medium to dark reddish-brown, provided with 2–3.5 μm high, truncate warts. *T. mauritiana* differs also from the 12 recognised *Tilletia* species on *Eriochloa* and *Panicum*, closely related to *Brachiaria*. *T. mauritiana* differs from *T. verrucosa* Cooke & Massee, type on *Panicum coloratum* L., in which the spores are 20–24 μm long, provided with 2–3 μm high, acute or subacute conical warts. In *Conidiosporomyces verruculosus* (Wakef.) Vánky, type on *Setaria aurea* A. Br., the hypertrophied, sac-like, opened sori are developing in some of the ovaries of an inflorescence, between the spores usually groups of Y-shaped conidia are present, and the spores are more finely ornamented than those of *T. mauritiana*.

THE FIRST SMUT FUNGUS OF *ENTEROPOGON* (GRAMINEAE)

Enteropogon Nees, with 17 species in the tropics, belongs to the subfam. Chloridoideae, tribe Cynodonteae, subtribe Chloridinae (Clayton & Renvoize, 1986:396). No smut fungus has yet been reported on this grass genus.

Ustilago enteropogonis Vánky, **sp. nov.**

Typus in matrice *Enteropogon ramosus* B. K. Simon (det. T. A. James, NSW), Australia, New South Wales, Bedgerebong, 'Tresta', 26.III.1982, leg. J. Bollinger & I. McGowen. Holotypus in DAR 41433, isotypus in Herbario Ustil. Vánky, HUV 19540.

Sori inflorescentiam totam, rarius partem illae tantum destruentes, fusiformes, 2–5 x 8–25 mm, vaginis supremis foliorum plus-minus absconditi, posterius lateraliter protrusi, massam atrobrunneam, pulveream, axem inflorescentialem circumdantem sporarum ostendentes. *Sporae* globosae, subglobosae, ovoideae, ellipsoidales vel parum irregulares, 9,5–13 x 10,5–14,5 μm, flavidobrunneae; pariete aequaliter crasso, 1–1,5 μm, spinis moderate dense distributis, cca. 0,5 μm altis inclusis; imago obliqua sporarum serrulata.

Sori (Fig. 12) destroying the whole inflorescence, more rarely only a part of it, fusiform, 2–5 x 8–25 mm, more or less concealed by the uppermost leaf sheaths, later laterally protruding and disclosing the dark brown, powdery mass of spores surrounding the axis of the inflorescence. *Spores* (Figs.17, 18) globose, subglobose, ovoid, ellipsoidal or slightly irregular, 9.5–13 x 10.5–14.5 μm, yellowish-brown; wall evenly thick, 1–1.5 μm, including the moderately densely situated, c. 0.5 μm high spines; spore profile serrulate.

On *Enteropogon ramosus* B. K. Simon; Australia. Known only from the type collection.

THE SMUT FUNGI OF NEURACHNINAE (GRAMINEAE)

The subtribe Neurachninae of the tribe Paniceae, subfam. Panicoideae has three genera, known only from Australia: *Thyridolepis* S. T. Blake, with 3 species, the unispecific *Paraneurachne* S. T. Blake, and *Neurachne* R. Br., with 6 species. No smut fungus is known on *Thyridolepis*. On *Paraneurachne* one smut, *Sporisorium paraneurachnis* R. G. Shivas & Vánky (1997:836) has been described. On *Neurachne*, *Ustilago tepperi* Ludwig (1889:341) is known. Checking unidentified smuts, a further species was discovered on *Neurachne tenuifolia*:

1. *Ustilago neurachnis* Vánky, **sp. nov.**

Typus in matrice *Neurachne tenuifolia* S. T. Blake, Australia, Northern Territory, SW of Standley Chasm, Mt. Conway, 23°45' S, 133°35' E, 15.VII.1989, leg. P. K. Latz 11571. Holotypus in DAR 65439, isotypi in HUV 19550, et in DNA 86449 (Alice Springs, Australia).

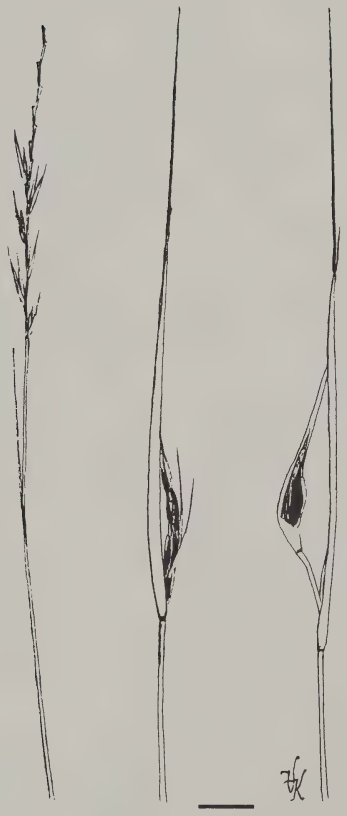

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Fig. 19. Sori of *Ustilago neurachnis* Vánky in the inflorescence of *Neurachne tenuifolia* S. T. Blake (type). To the left a healthy inflorescence. Bar = 1cm.

Sori inflorescentiam destruentes, fusiformes, cca. 3–4 x 15 mm, vaginis foliorum plus-minus occulti, serius prorumpentes massam atrobrunneam, semiagglutinatam usque pulveream sporarum et aliquot residua telarum nutrientium relinquentes. *Sporae* singulae, globosae, subglobosae usque late ellipsoidales, 6,5–8 x (6,5–)7–9(–9,5) µm, olivaceo-brunneae, verrucosae; pariete cca. 0,8 µm crasso, in area minuta tenuiore, cca. 5 µm lata, verrucis inclusis, in areis tenuioribus magis conspicuis; imago obliqua sporarum levis vel paene levis, in areis tenuioribus undulata. *Cellulae steriles* absentes.

Sori (Fig. 19) destroying the inflorescence, fusiform, c. 3–4 x 15 mm, more or less hidden by leaf sheaths, later bursting, releasing the dark brown, semiagglutinated to powdery mass of spores and several shreds of host tissues. *Spores* (Figs. 20, 21) single, globose, subglobose to broadly ellipsoidal, 6.5–8 x (6.5–)7–9(–9.5) µm, olivaceous-brown, verrucose; wall c. 0.8 µm thick, in a small area thinner, c. 5 µm wide, including the verrucae, which are more pronounced on the thin-walled area; spore profile smooth or nearly so, wavy on the thin-walled area. *Sterile cells* absent.

On Gramineae: *Neurachne tenuifolia* S. T. Blake; Australia. Known only from the type collection.

2. *Ustilago tepperi* Ludwig, 1889:341.

Syntypes on *Amphipogon* sp. & *Neurachne alopecuroides* R. Br., Australia, South Australia, Torrens Gorge and Highbury scrub, leg. J. G. O. Tepper (no type designated).

The *sori* of *U. tepperi* are like those of *U. neurachnis*. *Spores* single, subglobose, ellipsoidal to slightly irregular, 10.5–16 x 13–17(–18.5) µm, yellowish-brown; wall even, 1–1.5 µm thick, prominently, densely echinulate; spore profile serrulate. *Sterile cells* absent.

On *Neurachne alopecuroides* R. Br., *Amphipogon strictus* R. Br., and *Amphipogon* sp.; Australia.

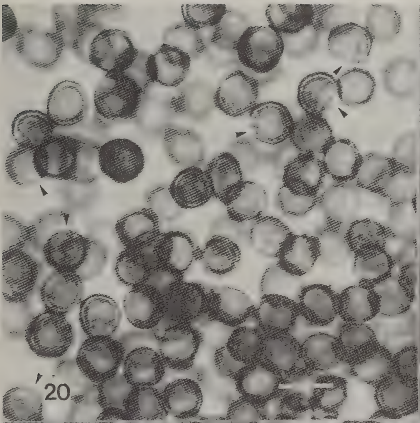
Key to the smut fungi of Neurachninae

1. The fungus induces witches' brooms. Peridium and spore balls present. On *Paraneurachne* .... *Sporisorium paraneurachnis*
– Witches' brooms, peridium and spore balls absent. On *Neurachne*..................2
2. Spores (6.5–)7–9(–9.5) µm long, verrucose .... *Ustilago neurachnis*
– Spores 13–17(–18.5) µm long, echinulate.............................. *Ustilago tepperi*

Figs. 20, 21. Spores of *Ustilago neurachnis* Vánky on *Neurachne tenuifolia* S. T. Blake, in LM and in SEM (type), with the typical thin-walled area (arrowheads in LM pictures, impressed in SEM picture).

Figs. 22, 23. Spores and sterile cells of *Tilletia aristidae* Vánky on *Aristida scabrivalvis* Hack. subsp. *contracta* in LM and in SEM (type).

Figs. 24, 25. Spore balls and spores of *Sporisorium inopinatum* Vánky on *Aristida scabrivalvis* Hack., in LM and in SEM (type). Note the high warts on the free surface of the spores in LM picture (arrowheads).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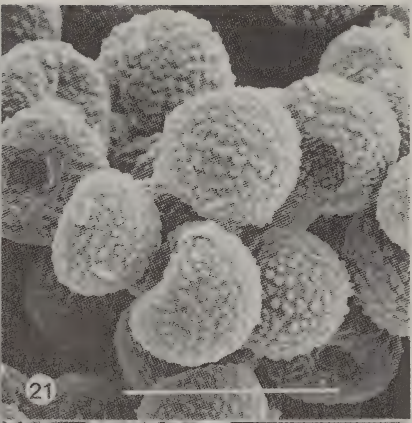
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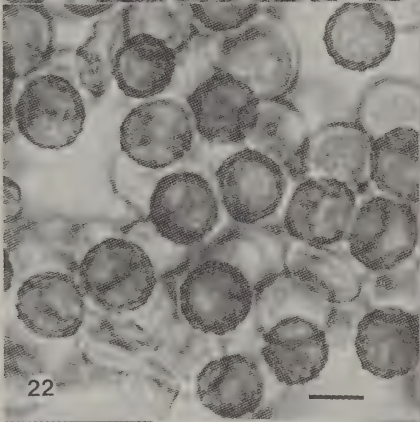
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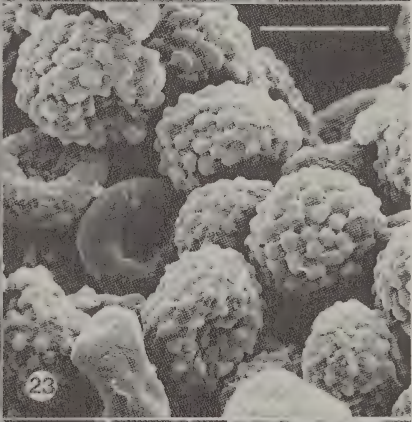
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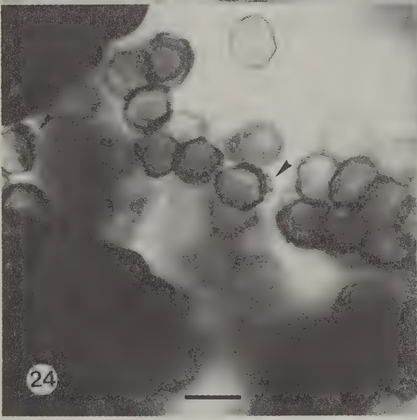
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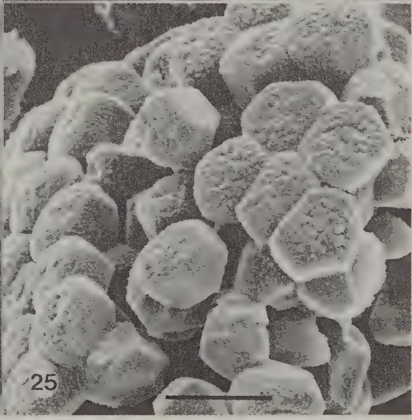
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TWO NEW SMUT FUNGI OF *ARISTIDA* (GRAMINEAE)

I revised the smut fungi of *Aristida* and *Stipagrostis* (Vánky, 2001:302-312) and recognised eleven species: **1**. *Macalpinomyces aristidae-cyananthae* (Bref.) Vánky, **2**. *Sporisorium aristidae* (S. Ahmad) Vánky, **3**. *S. aristidae-lanuginosae* (Maire) Vánky, **4**. *S. aristidicola* (Speg.) Vánky, **5**. *S. confusum* (H. S. Jackson) Vánky, **6**. *S. consanguineum* (Ellis & Everh.) Vánky, **7**. *S. fraserianum* (H. Sydow) Vánky, **8**. *S. goniosporum* (Massee) Vánky, **9**. *Tilletia oklahomae* Zundel, **10**. *T. palpera* J. Walker & Vánky, and **11**. *Ustilago aristidarius* Durán. Two additional smut fungi are described below.

1. *Tilletia aristidae* Vánky, sp. nov.

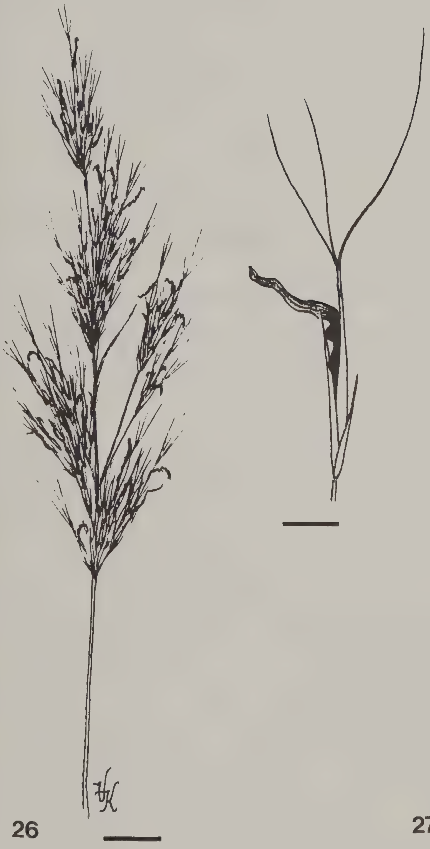
Typus in matrice *Aristida* sp. (= *A. scabrivalvis* Hack. subsp. *contracta* (De Winter) Meld., det. K. Vánky), Rep. of South Africa, KwaZulu-Natal Prov., prope Maritzburg, 26.VI.1911, leg. E. M. Doidge, BPI 179570.

Sori in ovariis omnibus inflorescentiae eiusdem, elongati, cca. 0,5 x 10–20 mm, brunnei, in maturitate longitudinaliter rupti massam atrobrunneam, semiagglutinatam usque pulveream sporarum cum cellulis sterilibus intermixtam dispergentes, pericarpium hypertrophicum saepe tortum, leve cum fasciculis vascularibus parallelis nonnulis relinquentes. *Sporae* globosae, ovoideae vel late ellipsoidales, raro cum appendice brevi, hyalina, (11–)12–14 x (11–)12–15 μm, flavae usque flavidobrunneae; pariete 1–2,5 μm crasso, verrucis humilibus, cca. 0,5 μm, obtusis, irregularibus, cca. 0,5 μm latis inclusis; imago obliqua sporarum undulata. *Cellulae steriles* ellipsoidales vel parum irregulares, 8–16 x 10–23 μm, pallide flavae; pariete 2–3 μm crasso, levi. "Sporae immaturae" paucae praesentes, pallidiores et plerumque majores quam sporae (15–18 μm longae), sparsim, leviter verrucosae.

Sori (Fig. 26) in all ovaries of an inflorescence, elongated, c. 0.5 x 10–20 mm, brown, at maturity they rupture longitudinally, the dark brown, semiagglutinated to powdery mass of spores intermixed with sterile cells is scattered leaving behind the hypertrophied, often curled, smooth pericarp with several parallel vascular bundles. *Spores* (Figs. 22, 23) globose, ovoid or broadly ellipsoidal, rarely with a short, hyaline appendage, (11–)12–14 x (11–)12–15 μm, yellow to pale yellowish-brown; wall 1–2.5 μm thick including the low, c. 0.5 μm, blunt, irregular, c. 0.5 μm wide warts; spore profile vawy. *Sterile cells* (Figs. 22, 23) ellipsoidal or slightly irregular, 8–16 x 10–23 μm, pale yellow; wall 2–3 μm thick, smooth. Few "immature spores" present, paler and usually larger than the spores (15–18 μm long), sparsely, finely verrucose.

On *Aristida scabrivalvis* Hack. subsp. *contracta* (De Winter) Meld.; S. Africa. Known only from the type collection.

Tilletia aristidae differs from *T. palpera* J. Walker & Vánky (type on *Aristida* sp., Australia) especially in sorus and spore morphology. In *T. palpera* the sorus membrane is thicker, not curled and is hairy on its inner side towards the lumen, the spores are larger, 14–19 x 15–20(–21) μm, and the warts are 1–2.5 μm high.



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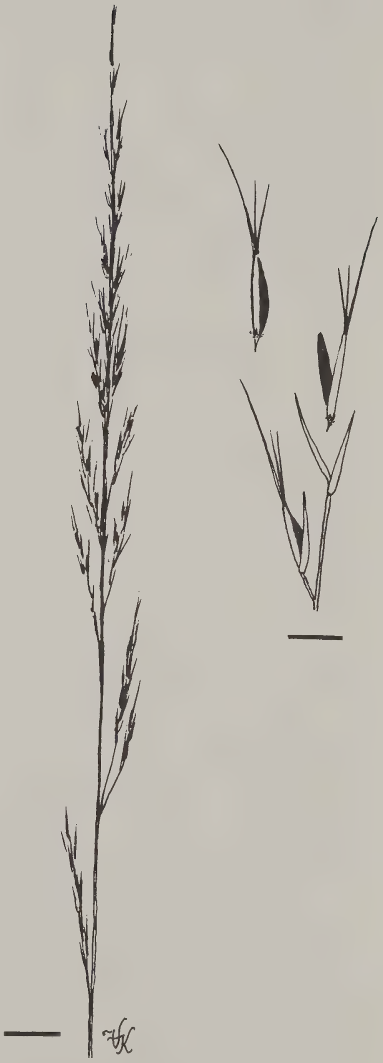

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Fig. 26. Sori of *Tilletia aristidae* Vánky in the hypertrophied ovaries of *Aristida scabrivalvis* Hack. subsp. *contracta* (De Winter) Meld. (type). Habit and enlarged a spikelet with a sorus.

Fig. 27. Sori of *Sporisorium inopinatum* Vánky in the ovaries of *Aristida scabrivalvis* Hack. (type). Habit and enlarged three sori, more or less hidden by the awned lemma. Bars = 1cm for the habit, 3 mm for the detail drawings.

2. *Sporisorium inopinatum* Vánky, sp. nov.

Typus in matrice *Aristida scabrivalvis* Hack. (det. S. Kativu), Zimbabwe, Matabeleland South Prov., 30 km SE urbe Bulawayo, 20°17'16" S, 28°55'55" E, alt. cca. 1180 m.s.m., 2.III.1999, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 18924, isotypi in BPI et in Vánky, Ust. exs. no. 1108. Paratypi in matrice *Aristida scabrivalvis* Hack. (det. S. Kativu), Zimbabwe, Matabeleland North Prov., Hwange National Park, Robins Camp. Crocodile Pool, 18°37'03" S, 26°02'22" E, alt. cca. 930 m.s.m., 9.III.1999, leg. C. & K. Vánky, HUV 18940!, et in matrice *Aristida adscensionis* L. (det. S. Kativu), Zimbabwe, Matabeleland North Prov., 75 km E oppid. Hwange, 10 km SW pag. Kamativi, 18°21'03" S, 27°03'16" E, alt. cca. 850 m.s.m., 13.III.1999, leg. C. & K. Vánky, HUV 18925!, isoparatypus in BPI; *Aristida adscensionis* L., Zambia, Southern Prov., 10 km NW pag. Monze, 16°11'51" S, 27°24'24" E, alt. cca. 990 m.s.m., 15.IV.2001, leg. C., T. & K. Vánky, HUV 19682!

Sori in nonnullis ovariis inflorescentiae eiusdem, inconspicui, lemmate aristato cooperti, latere tumefacto, parum protruso sori excepto, fusiformes, 0,5–1 x 4–5 mm, peridio primo viridi, serius brunneo, e pericarpio et hyphis composito obtecti. Plerumque sori inaperti ex planta decidentes adhuc lemmate inclusi. Rarius sori longitudinaliter secundum hilum caryopsidis pristinum disscissi, massam glomerulorum sporarum atrobrunneam, primo agglutinatam deinde granuloso-pulveream ostendentes. Columella nulla in soris. *Glomeruli sporarum* forma et magnitudine varii, subglobosi, ellipsoidales, elongati, plerumque irregulares, 30–100 x 50–120(–150) µm, atro-olivaceobrunnei, usque subopaci, semiperma-nentes, e pluries decem usque pluries centum, pressu separabilium sporarum compositi. *Sporae* conspicue dimorphae, subpolyedrice irregulares, raro globosae vel ellipsoidales, 8–11 x 8–12(–13) µm, sporae externae olivaceobrunneae, in superficie libera prominenter, dense verrucosae-echinulatae, verrucis 1–2(–2,5) µm altis; sporae internae pallidae, pariete tenui (cca. 0,5 µm), levi. *Cellulae steriles* inter glomerulos sporarum paucae, singulae vel raro in catervis parvis, globosae, subglobosae, ellipsoidales vel ovoideae usque parum irregulares, 6,5–11 x 8–14,5 µm, hyalinae; pariete 0.5–1,5 µm crasso, levi.

Sori (Fig. 27) in some ovaries of an inflorescence, inconspicuous, enclosed by the awned lemma except for a slightly protruding swollen side of the sorus, fusiform, 0.5–1 x 4–5 mm, first covered by a green, later brown peridium composed of the pericarp and fungal elements. Usually, the sori fall off the plants unopened, still enclosed by the lemma. More rarely, the sori split longitudinally along the former hilum of the caryopsis, disclosing the blackish-brown, first agglutinated later granular-powdery mass of spore balls. No columella in the sori. *Spore balls* (Figs. 24, 25) variable in shape and size, subglobose, ellipsoidal, elongated, usually irregular, 30–100 x 50–120(–150) µm, dark olivaceous-brown to subopaque, semipermanent, composed of tens to hundreds of spores which separate by pressure. *Spores* (Figs. 24, 25) distinctly dimorphic, subpolyhedrally irregular, rarely globose or ellipsoidal, 8–11 x 8–12(–13) µm, outer spores olivaceous-brown, on the free surface prominently, densely verrucose-echinulate, warts 1–2(–2.5) µm high; inner spores pale, wall thin (c. 0.5 µm), smooth. *Sterile*

cells between the spore balls few, single or rarely in small groups, globose, subglobose, ellipsoidal or ovoid to slightly irregular, 6.5–11 x 8–14.5 µm, hyaline; wall 0.5–1.5 µm thick, smooth.

On *Aristida adscensionis* L., and *A. scabrivalvis* Hack.; C. & S. Africa (Zambia, Zimbabwe).

Etymology: *inopinatum* from the Latin inopinatus, -a, -um (= unexpected) because, when collected, it was not expected that this would be a new species.

Sporisorium inopinatum is close to *S. consanguineum* (Ellis & Everh.) Vánky (type on *Aristida arizonica* Vasey, USA), from which it differs mainly in the size of the spores and in the spore ornamentation. In *S. consanguineum* the spores are 6.5–9(–10) µm long, the free surface of the spores is finely verruculose.

TWO NEW SMUT FUNGI OF *DACTYLOCTENIUM* (GRAMINEAE)

I revised the smut fungi of *Dactyloctenium* (Vánky, 1995:232-233, 1996a:94-95, 1999c:144-148) and recognised nine species: **1**. *Tilletia dactyloctenii* Vánky, **2**. *T. eleusinis* H. Sydow, **3**. *Ustilago ctenioides* Vánky, **4**. *U. dactyloctenii* Henn., **5**. *U. dactylocteniophila* Henn., **6**. *U. idonea* H. Sydow, **7**. *U. radulans* Vánky, **8**. *U. sparsa* Underw., and **9**. *U. viviparifera* Vánky, C. Vánky & N. D. Sharma. Two additional species are described below.

1. *Tilletia tanzanica* Vánky, sp. nov.

Holotypus in matrice *Dactyloctenium giganteum* Fisher & Schweick., Tanzania, without closer data, intercepted by the Australian Quarantine Services, J. Strickland, C.P.I. 59680, in a seed consignment, DAR 23495.

Sori in ovariis, ovoidei cum apice acuto, 1–2 x 1,5–3 mm, membrana (pericarpio) tenui, primo viridi, serius brunneo cooperti, quo irregulariter rupto massam nigrobrunneam, pulveream sporarum cum cellulis sterilibus intermixtam ostendentes. *Sporae* forma et magnitudine satis variae, globosae, subglobosae, ovoideae, ellipsoidales, raro parum irregulares, 22–32 x (22–)24–33(–36) µm, flavido- usque rubrobrunneae, reticulatae, 4–7 maculis per diametrum sporae, maculis sat frequenter incompletis, muris 1,5–2,5 µm altis, interstitiis saepe verrucosis. *Cellulae steriles* forma magnitudineque variae, globosae, ellipsoidales vel irregulares, 13–26 x 14,5–31 µm, hyalinae; pariete 1,5–4 µm crasso, homogeneo vel raro bistratoso, levi.

Sori (Fig. 28) in ovaries, ovoid with an acute tip, 1–2 x 1.5–3 mm, covered by a thin, first green later brown membrane (pericarp) which ruptures irregularly disclosing the blackish-brown, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 30, 31) rather variable in shape and size, globose, subglobose, ovoid, ellipsoidal, rarely slightly irregular, 22–32 x (22–)24–33(–36) µm, yellowish- to reddish-brown, reticulate, 4–7 meshes per spore diam., meshes rather often incomplete, muri 1.5–2.5 µm high, interspaces often verrucose. *Sterile cells* (Figs. 30, 31) variable in shape and size, globose, ellipsoidal or irregular, 13–26 x 14.5–31 µm, hyaline; wall 1.5–4 µm thick, homogenous or rarely two-layered, smooth.

On *Dactyloctenium giganteum* Fisher & Schweick.; Tanzania. Know only from the above-mentioned seed collection.

Two further *Tilletia* species are known on *Dactyloctenium*, both on *D. aegyptium* (L.) Beauv. from India: *T. dactyloctenii* Vánky, in which the spores are peculiarly spiny-reticulate, and *T. eleusines* H. Sydow, in which the spores are 20–25 x 20–25(–28) µm, with 4–6 meshes per spore diameter, the muri are 1–1.5(–2) µm high, the sterile cells are 8–20 µm long with 1–1.5 µm thick wall.

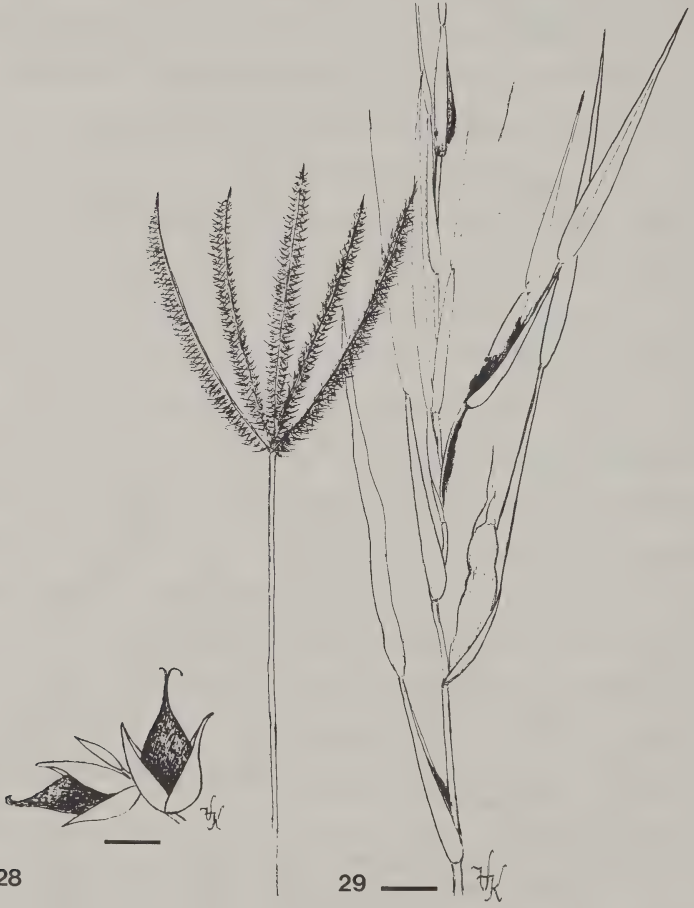


Fig. 28. Sori of *Tilletia tanzanica* Vánky in the ovaries of *Dactyloctenium giganteum* Fisher & Schweick. (type). Enlarged two sori. Bar = 2 mm.

Fig. 29. Sori of *Ustilago dactyloctenii-gigantei* Vánky in the inflorescence, uppermost leaves and internodes of *Dactyloctenium giganteum* Fisher & Schweick. (type). Habit and a healthy inflorescence. Bar = 1cm.

A smut fungus, collected in Zimbabwe on *Dactyloctenium giganteum*, is in its appearence similar to *Ustilago dactyloctenii* Henn. (type on *D. aegyptium* (L.) Beauv.), *U. idonea* H. Sydow (type on *D. sindicum* Boiss.), and *U. radulans* Vánky (type on *D. radulans* (R. Br.) Beauv.). However, study of its spores revealed that it is a different species:

2. *Ustilago dactyloctenii-gigantei* Vánky, sp. nov.

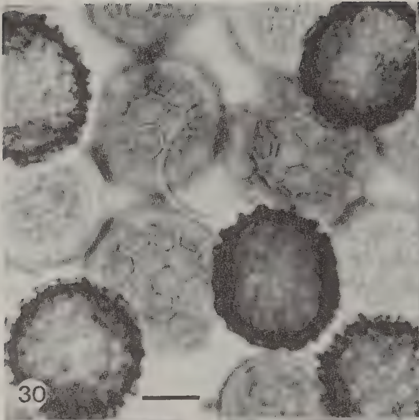
Typus in matrice *Dactyloctenium giganteum* Fisher & Schweick., Zimbabwe, Matabeleland North Prov., 227 km NW Bulawayo, oppid. Gwayi River, 18°36'56" S, 27°11'47" E, alt. cca. 1000 m, 5.III.1999, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19492. Paratypi: Matabeleland North Prov., Hwange National Park, Shumba Picnic Area, 18°50'31" S, 26°22'39" E, alt. cca. 1100 m, 7.III.1999, leg. C. & K. Vánky, HUV 19493; Matabeleland North Prov., 86 km NNE oppid. Kamativi, 17°49'42" S, 27°21'27" E, alt. cca. 800 m, 18.III.1999, leg. C. & K. Vánky, HUV 19494.

Sori inflorescentiam totam, etiam folia suprema vel partem basalem eorum et internodia destruentes, 2–4 x 10–20 mm, vaginis foliorum absconditi et strato cinereo tenui epidermidis plantae nutrientis cooperti, quo rupto massam atrobrunneam, pulveream sporarum dispersarum, axem inflorescentialem sicut columellam contractam relinquentem ostendentes. *Sporae* globosae, ovoideae, ellipsoidales, elongatae, parum irregulares, 9,5–12,5 x 10–15 µm, flavido-brunneae; pariete aequaliter crasso, dense prominenter echinulatae, spinis cca. 1 µm altis, imago obliqua sporarum serrata. *Cellulae steriles* nullae.

Sori (Fig. 29) destroying the whole inflorescence, the uppermost leaves or their basal part, and also the internodes, 2–4 x 10–20 mm, concealed by leaf sheaths and covered by a thin, grey layer of host epidermis which ruptures, disclosing the dark brown, powdery mass of spores which are scattered leaving behind the inflorescence axis as a tapering columella. *Spores* (Figs. 32, 33) globose, ovoid, ellipsoidal, elongated, slightly irregular, 9.5–12.5 x 10–15 µm, yellowish-brown; wall evenly thick, densely, prominently echinulate, spines c. 1 µm high, spore profile serrate. *Sterile cells* absent.

On *Dactyloctenium giganteum* Fisher & Schweick.; S. Africa (Zimbabwe).

Ustilago dactyloctenii-gigantei differs from *U. idonea* by the size of the spores. The spores of *U. idonea* are 7–11 µm long. *U. dactyloctenii-gigantei* differs from *U. dactyloctenii* and from *U. radulans* by the spore ornamentation. The spores of *U. dactyloctenii* are very finely, densely punctate, those of *U. radulans* are sparsely echinulate and the spines are also lower and wider than those in *U. dactyloctenii-gigantei*.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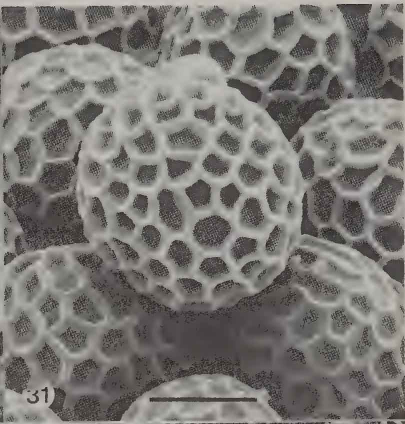
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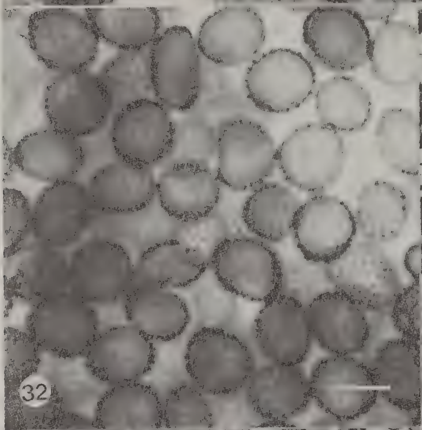
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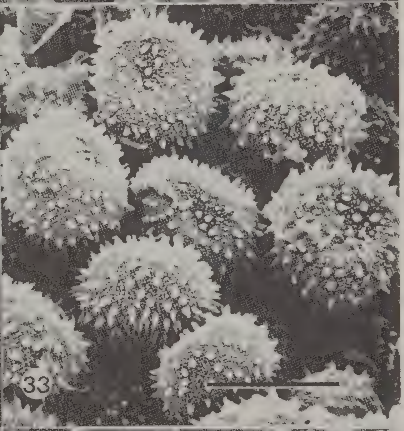
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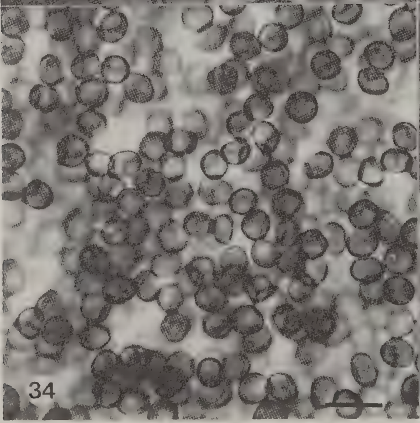
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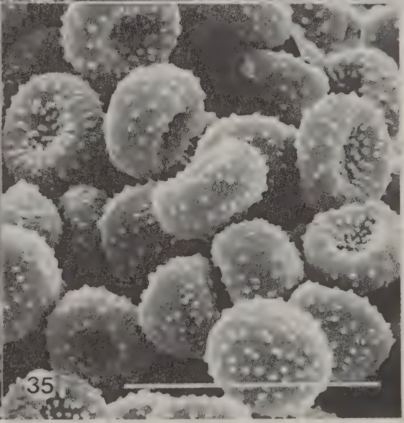
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A SMUT FUNGUS ON *MEGALOPROTACHNE* (GRAMINEAE)

Megaloprotachne C. E. Hubb. is a unispecific genus in the subfam. Panicoideae, tribe Paniceae, subtribe Digitariinae, in Southern Africa (Clayton & Renvoize, 1986:298). No smut fungus has yet been reported on it.

Sporisorium megaloprotachnes Vánky & T. Vánky, **sp. nov.**

Typus in matrice *Megaloprotachne albescens* C. E. Hubb., Malawi, Northern Province, 81 km SSW urbe Mzuzu, Viphya Plateau, 11°55'49" S, 33°43'05" E, alt. cca. 1550 m.s.m., 23.IV.2001, leg. T., C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19622, isotypi in BPI et in IMI 386803.

Sori inflorescentiam totam destruentes, longe cylindrici, 1–3 x 15–60 mm, primo peridio cinerascenti cooperti, quo irregulariter rupto massam atrobrunneam, pulveream sporarum et columellas complures filiformes ostendentes. Infectio systemica, surculi omnes eiusdem plantae soros producentes. *Spores* maturae singulae, subglobosae, ellipsoidales usque parum irregulares, 4,5–6 x 5–6,5 µm, olivaceobrunneae; pariete tenui (cca. 0,5 µm), leniter, satis sparse verruculoso; imago obliqua sporarum levis usque undulata. *Cellulae steriles* non observatae.

Sori (Fig. 36) destroying the whole inflorescence, long cylindrical, 1–3 x 15–60 mm, first covered by a greyish peridium which ruptures irregularly disclosing the dark brown, powdery mass of spores and numerous filiform columellae. Infection systemic, all shoots of a plant producing sori. *Spores* (Figs. 34, 35) when mature single, subglobose, ellipsoidal to slightly irregular, 4.5–6 x 5–6.5 µm, olivaceous-brown; wall thin (c. 0.5 µm), finely, rather sparsely verruculose; spore profile smooth to wavy. *Sterile cells* not seen.

On *Megaloprotachne albescens* C. E. Hubb.; C. Africa (Malawi). Known only from the type collection.

Figs. 30, 31. Spores and sterile cells of *Tilletia tanzanica* Vánky on *Dactyloctenium giganteum* Fisher & Schweick. (type).

Figs. 32, 33. Spores of *Ustilago dactyloctenii-gigantei* Vánky on *Dactyloctenium giganteum* Fisher & Schweick., in LM and in SEM (type).

Figs. 34, 35. Spores of *Sporisorium megaloprotachnes* Vánky & T. Vánky on *Megaloprotachne albescens* C. E. Hubb., in LM and in SEM (type).

Bars = 10 µm.

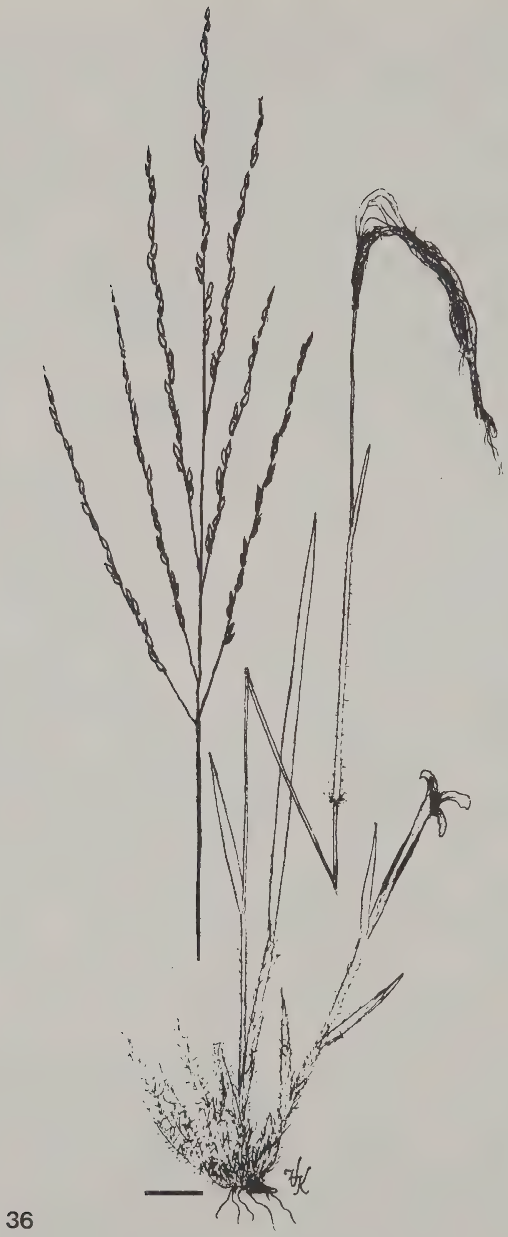


Fig. 36. Sori of *Sporisorium megaloprotachnes* Vánky & T. Vánky in the inflorescences of *Megaloprotachne albescens* C. E. Hubb. (type), and a healthy inflorescence. Bar = 1 cm.

THE SMUT FUNGI OF CENCHRINAE (GRAMINEAE)

The subtribe Cenchrinae of the tribe Paniceae in the subfam. Panicoideae includes 13 genera (Clayton & Renvoize, 1986:301). Of these, smut fungi have been reported on *Anthephora* (2 spp.), *Cenchrus* (9), *Pennisetum* (26), and *Pseudoraphis* and *Chamaeraphis* (4). Because several grasses have been placed alternatively in one of these genera, and because some smuts (e.g. *Sporisorium penniseti*) may infect both *Cenchrus* and *Pennisetum*, it is best to treat the smut fungi of the Cenchrinae together. Of these, the smut fungi of *Pseudoraphis* and *Chamaeraphis* have been treated already (Vánky, 1998:330-337), those of *Pennisetum* will be published in the next number of this series. Several of the smut fungi of the Cenchrinae are synonyms, others do not belong to the genus in which they were described originally. Some turned out to be new species, others are excluded from the smut fungi.

I. The smut fungi of *Anthephora*

On *Anthephora* Schreb., with 12 species, mainly in Africa, two smut fungi are known: *Ustilago anthephorae* H. & P. Sydow, and *Sorosporium anthephorae* L. Ling. Actually, both belong to the genus *Sporisorium*.

1. *Sporisorium anthephorae* (H. & P. Sydow) Vánky, **comb. nov.**

Basionym: *Ustilago anthephorae* H. & P. Sydow, Ann. Mycol. 12:197, 1914. — *Sphacelotheca anthephorae* (H. & P. Sydow) Zundel, 1938:295. — Type on *Anthephora pubescens* Nees, Namibia, Grootfontein, 10.IV.1913, A. Engler.

Sori in the spikelets, infecting all in the inflorescence, long cylindrical, first covered by a greyish peridium which ruptures into long shreds disclosing the dark brown powdery mass of spore balls, spores and an up to 10 mm long central columella often with short apical branches. *Spore balls* subglobose, ellipsoidal, oblong to slightly irregular, 30–60 x 40–70(–80) µm, dark reddish-brown to subopaque, composed of tens of spores which separate easily. *Spores* single, globose, subglobose, ellipsoidal, often flattened on one side, 5–6(–6.5) x 5–7 µm, medium dark yellowish-brown; wall c. 0.5 µm thick, slightly thinner on one side, sparsely verrucose-echinulate which just affects the spore profile. *Sterile cells* between the spores not seen.

On *Anthephora nigritana* Stapf & Hubbard, and *A. pubescens* Nees; W. & S. Africa (Nigeria, Rep. of South Africa).

2. *Sporisorium lingianum* Vánky, **nom. nov.**

pro *Sorosporium anthephorae* L. Ling, Lloydia 16:184, 1953a; non *Sporisorium anthephorae* (H. & P. Sydow) Vánky. — Type on *Anthephora acuminata* Robyns, Nyasaland [= Malawi], Central Prov., Mzimba Distr., 29.IX.1950, G. Jackson, IMI 44451, isotype HUV 17365!

Sori in all spikelets of an inflorescence, cylindrical, 0.5–1 x 3.5–7 mm, first covered by a greyish-brown peridium which later ruptures into long shreds revealing a dusty, dark brown mass of loose spore balls and spores surrounding a simple central columella of the length of the sorus. *Spore balls* subglobose, ovoid, oblong or irregular, c. 35–70 x 40–100 µm, evanescent at maturity. *Spores* variable in shape and size, subglobose, ellipsoidal, usually subpolyhedrally irregular, 7–9.5 x 8–11 µm, reddish-brown; wall unevenly thick, 0.5–1.5 µm, thicker at the angles and on the free surface of a ball, finely, densely verrucose-echinulate, spore profile wavy to finely serrulate. *Sterile cells* between the spores not seen.

On *Anthephora acuminata* Robyns, *A. elongata* De Wild.; C. Africa (Malawi).

Etymology: This fungus is named in the honour of the excellent ustilaginologist Dr. Lee Ling, the author of "The Ustilaginales of China" (1953:b), and of several taxonomic papers of high value on different groups of smut fungi in which he described numerous new species, between them also this one.

Key to the smut fungi of *Anthephora*

– Spores 5–7 µm long, sparsely verrucose-echinulate ... *Sporisorium anthephorae*
– Spores 8–11 µm long, densely verrucose-echinulate ...... *Sporisorium lingianum*

II. The smut fungi of *Cenchrus*

On *Cenchrus* L., with 22 species occuring throughout the tropics, at least 9 smut fungi have been described of which several are synonyms. The recognised five species, including a new one, are:

1. *Sporisorium cenchri* (Lagerh.) Vánky, 1985:114.

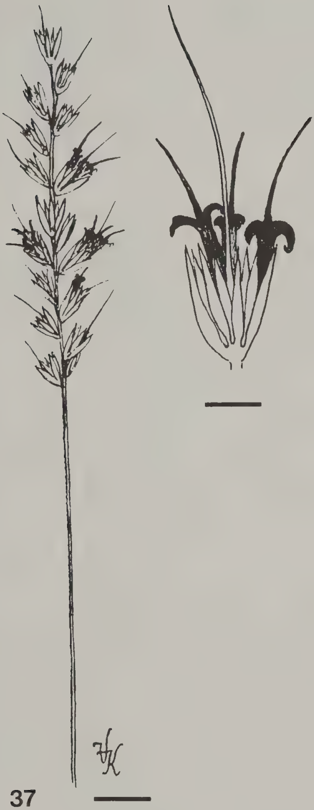
Ustilago cenchri Lagerh., in Patouillard & Lagerheim, 1895:62. — Type on *Cenchrus* sp., Ecuador, Riobamba, VIII.1891, G. Lagerheim, S!

For description, synonyms and illustrations see Vánky, 1994a:200 & 211.

On *Cenchrus brownii* Roem. & Schult., *C. ciliaris* L. (*Pennisetum ciliare* (L.) Link; *Pennisetum cenchroides* Rich.), *C. echinatus* L., *C. gracillimus* Nash, *C. incertus* M. A. Curtis (*C. carolinianus* Walt.), *C. myosuroides* H. B. K., *C. pauciflorus* Benth., *C. pilosus* H. B. K. (*C. tribuloides* auctt. eur. non L.), *Panicum capillare* L., *P. dichotomiflorum* Michaux (*Panicum proliferum* Lam.); Rather common in N. & S. America, scattered in Europe, Asia, Africa, where probably introduced. To elucidate if the morphologically similar smut on *Panicum* represents the same species, further studies are needed.

2. *Sporisorium cenchri-elymoidis* Vánky & R. G. Shivas, **sp. nov.**

Typus in matrice *Cenchrus elymoides* F. Muell. var. *brevisetosus* B. K. Simon, Australia, Western Australia, Kimberley Region, Corneille Island, 14°11'31" S, 125°44'16" E, 18.V.1998, leg. A. A. Mitchell. Holotypus in BRIP 26491, isotypus in HUV 19086. Paratypus in matrice *Cenchrus elymoides* F. Muell., Corneille Island, 14°12' S, 125°44' E, alt. cca. 5 m.s.m., 8.IV.1991, leg. A. G. P. Brown, PERTH 1359037.



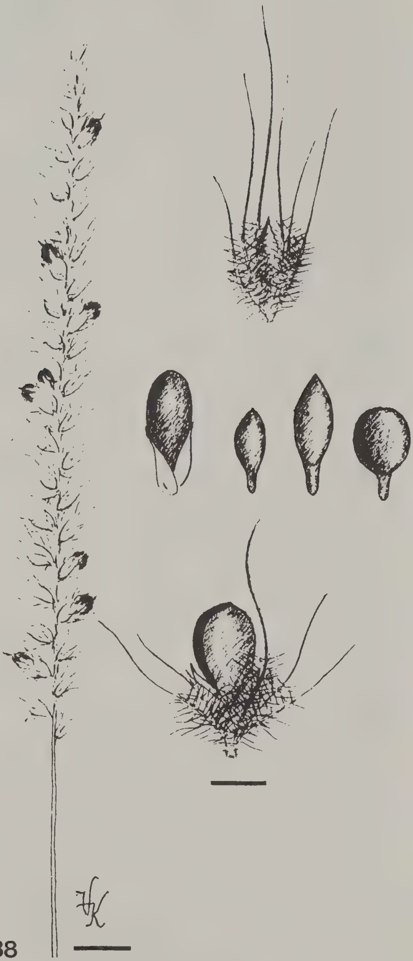


Fig. 37. Sori of *Sporisorium cenchri-elymoidis* Vánky & R. G. Shivas in some clusters of spikelets (burrs) of *Cenchrus elymoides* F. Muell. var. *brevisetosus* B. K. Simon (type). Habit and enlarged three sori within a burr.

Fig. 38. Sori of *Tilletia pseudochaetochloae* R. G. Shivas & Vánky in the ovaries of *Pseudochaetochloa australiensis* Hitchc. (type). Habit and enlarged a healthy spikelet (top) and some sori.

Bars = 1 cm for the habit, 3 mm for the detail drawings.

Sori in spiculis unam vel nonnullam earum in fasciculis spiculorum inficientes, cylindrici, 1–1,5 x 8–15 mm, primo peridio cinereobrunneo cooperti, quo ab apice rupto massam nigrescentibrunneam, primo agglutinatam, deinde pulveream glomerulorum sporarum laxarum et sporarum columellam bene evolutam, usque 25 mm longam, tenuiescentem, centralem circumdantium ostendentes. *Glomeruli sporarum* varii, atro-flavidobrunnei, e sporis sat multis, leviter separabilibus compositi. *Sporae* subpolyedricae vel polyedriciter irregulares, magis raro globoideae vel ellipsoidales, 7–9,5 x 8–12 µm, flavidobrunneae; pariete inaequaliter crasso, 0,5–1 µm, in angulis parum crassiore et cum areolis nonnullis rotundis, tenuioribus, in imagine sub SEM sicut depressiones apparentibus; superficie valde subtiliter, dense punctata-verruculosa, imago obliqua sporarum levis. *Cellulae steriles* non obseratae.

Sori (Fig. 37) in the spikelets infecting one or several in the burrs (clusters of spikelets), cylindrical, 1–1.5 x 8–15 mm, first covered by a greyish-brown peridium which ruptures from its apex disclosing the blackish-brown, first agglutinated later powdery mass of loose spore balls and spores surrounding a well-developed, up to 25 mm long, tapering, central columella. *Spore balls* (Figs. 39, 40) variable, dark yellowish-brown, composed of a rather great number of easily separating spores. *Spores* (Figs. 39, 40) subpolyhedrally or polyhedrally irregular, more rarely globoid or ellipsoidal, 7–9.5 x 8–12 µm, yellowish-brown; wall slightly unevenly thick, 0.5–1 µm, somewhat thicker at the angles and with several, rounded, thinner areas which appear in the SEM picture as depressions; surface very finely, densely punctate-verruculose, spore profile smooth. *Sterile cells* not seen.

On *Cenchrus elymoides* F. Muell., and its var. *brevisetosus* B. K. Simon; Australia.

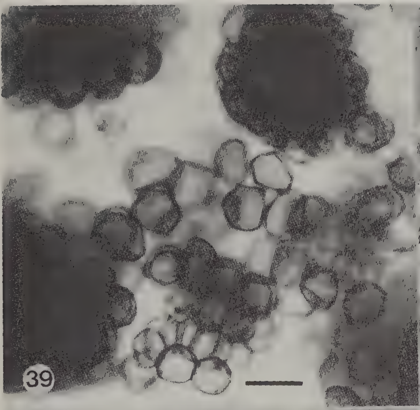
Some smutted seeds of "*Pennisetum* sp." originating from Nairobi, possessing "spherical, very firmly agglutinated, hard", black sori, were described by Zundel (1931:299) as *Cintractia dubiosa* sp. nov. Zundel was in doubt regarding the generic placement of his fungus. Ling (1953a:189) placed it into the genus *Sorosporium*, based on the presence of spore balls that were overlooked by Zundel. Ling also amended the spore measurements of Zundel (12–14 µm), giving values of 6.7–9.5 x 7.5–10.5 µm. The type specimen, preserved in BPI, contains only some spikelets, all with immature sori.

Figs. 39, 40. Spore balls and spores of *Sporisorium cenchri-elymoidis* Vánky & R. G. Shivas on *Cenchrus elymoides* F. Muell. var. *brevisetosus* B. K. Simon, in LM and in SEM (type).

Figs. 41, 42. Spores and sterile cells of *Tilletia pseudochaetochloae* R. G. Shivas & Vánky on *Pseudochaetochloa australiensis* Hitchc. in LM and SEM (type).

Figs. 43 & 44. Spores of *Entyloma coreopsis* Vánky on *Coreopsis boriana* Sch. Bip., and *E. aeschynomenis* Vánky on *Aeschynomene indica* L., in LM (types).

Bars = 10 µm.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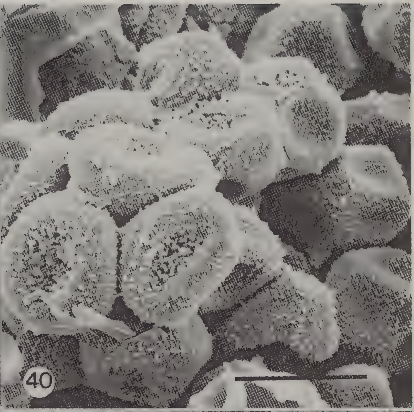
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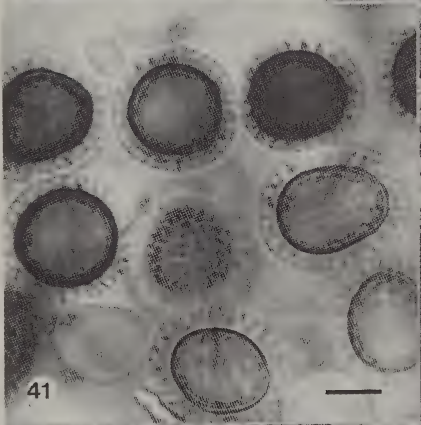
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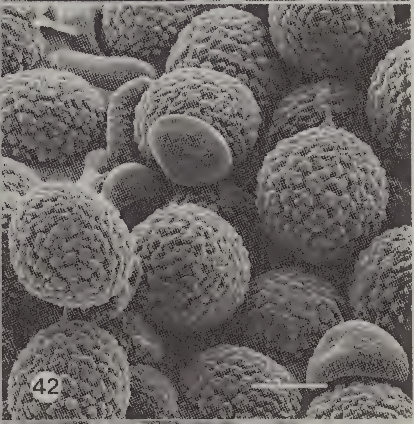
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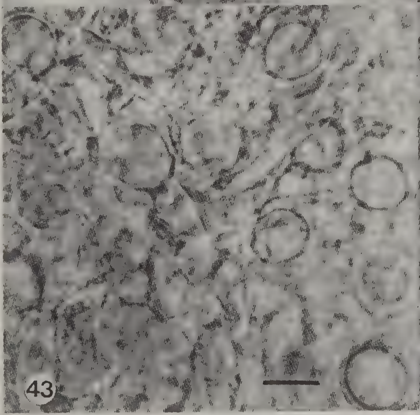
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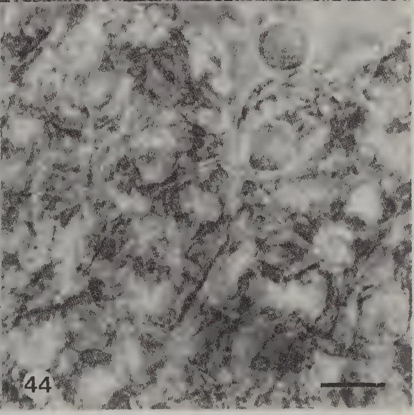
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Recently, Dr. R. Berndt (Tübingen, Germany), collected two different smut fungi in the spikelets of *Cenchrus ciliaris* L. in Namibia. One of them was identified as *Sorosporium dubiosum* (Zundel) L. Ling. The fungus produces stunting and witches' broom-like proliferation of the shoots and shows characters of the genus *Sporisorium*. Its complemented description, based also on the rich material from Namibia, is:

3. ***Sporisorium dubiosum*** (Zundel) Vánky, **comb. nov**.

Basionym: *Cintractia dubiosa* Zundel, Mycologia 23:299, 1931. — *Sorosporium dubiosum* (Zundel) L. Ling, 1953a:189. — Type on *Pennisetum* sp. (= *Cenchrus ciliaris* L., teste K. Vánky), British East Africa [= Kenya], Nairobi, 9.IX.1920, H. L. Shantz. Holotype in BPI 171508!, isotypes in BPI 171509 & 171510.

Sori in all spikelets of an inflorescence; usually all inflorescences of a plant are affected. The fungus produces stunting and witches' broom-like proliferation of the shoots with diseased inflorescences. Single sori globoid, 1.5–2 mm in diameter, first covered by a thin, greyish peridium which ruptures irregularly disclosing the blackish-brown, first agglutinated, later granular-powdery mass of spore balls surrounding several, short, often branching and anastomosing columellae of the length of the sorus. *Spore balls* globose, ellipsoidal, elongated or irregular, variable in size, 15–50 x 20–60 µm, dark reddish-brown to subopaque, composed of 15–50 (or more?) spores, which separate by pressure. *Spores* subglobose, ellipsoidal to slightly irregular, 6.5–10.5 x 7–11 µm, yellowish- to reddish-brown; wall even, 0.5–1 µm thick, finely, densely punctate-verruculose, more evident on the free surface, inner spores apparently smooth or finely punctate, somewhat smaller and lighter coloured than the outer spores; spore profile smooth to rough. *Sterile cells* not seen.

On *Cenchrus ciliaris* L. (*Pennisetum cenchroides* Rich.); Known only from a few collections from C. & S. Africa (Kenya, Namibia).

4. ***Sporisorium myosuroidis*** (Hirschh.) Vánky, **comb. nov**.

Basionym: *Sorosporium myosuroidis* Hirschhorn, Revista Mus. La Plata, N. S., Bot. 3:343, 1941. — Type on *Cenchrus myosuroides* H. B. K., Argentina, Corrientes, Capital, XI.1934, L. R. Parodi 1119, Herb. Hirschhorn 132!

Sori destroying the whole inflorescence, cylindrical, c. 0.5 x 9 cm, at first covered by a dirty white peridium which disintegrates disclosing the dark brown, first agglutinated later dusty mass of spore balls and numerous filiform columellae. *Spore balls* subglobose to ellipsoidal, 30–65 x 35–80 µm, dark reddish-brown, rather permanent, composed of tens of spores which separate by pressure. *Spores* subglobose, ellipsoidal to subpolyhedrally irregular, 6.5–8 x 7–9(–9.5) µm, yellowish-brown; wall slightly unevenly thick (0.5–1 µm), thicker on the free surface of the outermost spores in a ball and at the angles, surface finely, densely punctate-verrucose, spore profile smooth. *Sterile cells* not seen.

On *Cenchrus myosuroides* H. B. K.; S. America (Argentina).

The type specimen of *S. myosuroidis* is almost completely destroyed by insects. The host identity could not be checked for lack of healthy plants.

5. *Sporisorium penniseti* (Rabenh.) Ershad, 1994:18.
Neotype on *Pennisetum orientale* Rich., "Taurus Catasnicus", 1865, C. Haussknecht, JE!

For history and neotype see Vánky, 2000a:211. Description and synonyms will be published next year, in the series Taxonomical studies on Ustilaginales, XXIII, chapter The smut fungi of *Pennisetum*.

On *Cenchrus biflorus* Roxb. (*C. catharticus* Delile), *C. ciliaris* L. (*Pennisetum ciliare* (L.) Link), *C. prieurii* (Kunth) Maire (*Pennisetum prieurii* Kunth; *P. cenchroides* Rich.), *C. setigerus* Vahl (*C. biflorus* auct. non Roxb.), *Pennisetum divisum* (Forssk. ex Gmel.) Henrard (*P. dichotomum* (Forssk.) Delile), *P. flaccidum* Griseb., *P. macrourum* Trin., *P. natalense* Stapf, *P. orientale* Rich. (*P. fasciculatum* Trin.), *P. setaceum* (Forssk.) Chiov. (*P. orientale* Rich. var. *altissimum* Chiov.; *P. ruppellii* Steudel); S. Europe (Mediterranean area), Africa (incl. Madagascar), S. Asia.

Key to the smut fungi (*Sporisorium*) of *Cenchrus*

1. Sori in the whole inflorescence. Columella long, filiform 2
– Sori in the spikelets. Columella short, stout 3
2. Spores 8–12(–13) µm long.. *S. cenchri*
– Spores 7–9(–9.5) µm long .... *S. myosuroidis*
3. Sori in some spikelets of an inflorescence. Columella up to
25 mm long .... *S. cenchri-elymoidis*
– Sori in all spikelets of an inflorescence. Columella/ae a few mm long 4
4. Plants stunted, forming witches' brooms. Spores 7–11 µm long. ..... *S. dubiosum*
– Plants not so. Spores (9–)10–14.5 µm long.................................... *S. penniseti*

III. A smut fungus on *Pseudochaetochloa*

The unispecific *Pseudochaetochloa* Hitchc from Australia, belongs also to the subtribe Cenchrinae. No smut fungus has yet been reported on it.

Tilletia pseudochaetochloae R. G. Shivas & Vánky, **sp. nov.**
Typus in matrice *Pseudochaetochloa australiensis* Hitchc., Australia, Western Australia, Kimberley Reg., Black Rock pr. Kununurra, 14°46' S, 128°44' E, alt. cca. 20 m.s.m., 2.V.1989, leg. R. G. Shivas. Holotypus in PERTH 926817, isotypus in HUV 17447.

Sori in ovariis nonnullis inflorescentiae eiusdem, conspicui, primo virides, fusiformes, deinde brunnei, obovoidei, cum parte una pedicelliforme, proximali, tenue, 2–5 x 4–8(–10) mm, pericarpio cooperti, quo longitudinaliter rupto massam nigricantibrunneam, pulveream sporarum et cellularum sterilium ostendentes. *Sporae* globosae, ovoideae vel late ellipsoidales, 18–22(–25) x 18–25(–28) µm, pallide usque atro-flavidobrunneae, cum verrucis dense dispositis, 2,5–4 µm altis, subacutis vel obtusis. Verrucae nonnullae fusionis aptae, areas irregulariter polyangulares, magnitudine differentes, in visu superficiali obscuriores apparentes, 6–12 per diametrum sporae formantes. *Cellulae steriles* magnitudine nimie variae, 10–50(–55) µm longae, hyalinae usque pallide flavidobrunneae, saepe collapsae; pariete 1–7 µm crasso, subtiliter multistratoso, levi.

Sori (Fig. 38) in some ovaries of an inflorescence, conspicuous, first green, fusiform, later brown, obovoid with a narrow, pedicel-like proximal part, 2–5 x 4–8(–10) mm, covered by the pericarp which ruptures longitudinally disclosing the blackish-brown, powdery mass of spores and sterile cells. *Spores* (Figs. 41, 42) globose, ovoid or broadly ellipsoidal, 18–22(–25) x 18–25(–28) µm, pale to dark yellowish-brown, provided with densely situated, 2.5–4 µm high, subacute or blunt warts. Several warts may fuse forming irregularly polyangular areas of different sizes appearing darker in surface view, 6–12 per spore diameter. *Sterile cells* (Fig. 41) extremely variable in size, 10–50(–55) µm long, from hyaline to pale yellowish-brown, often collapsed; wall 1–7 µm thick, finely multilayered, smooth.

On *Pseudochaetochloa australiensis* Hitchc. (*Pennisetum arnhemicum* F. Muell.); Australia.

Tilletia pseudochaetochloae differs from *T. barclayana* (Bref.) Sacc. & P. Sydow, on different *Pennisetum* species, in which the spores are darker, somewhat larger (21–30 µm long), the warts are lower (1–2 µm high) and finer (10–15 per spore diameter), and the sterile cells are smaller (up to 30 µm long).

THREE NEW *ENTYLOMA* SPECIES (ENTYLOMATACEAE)

1. *Entyloma coreopsis* Vánky, sp. nov.

Typus in matrice *Coreopsis borianiana* Sch. Bip. ex Schweinf., Ethiopia, Nekempt, Airfield, 17.X.1968, leg. J. Kranz 40. Holotypus in IMI 140734, isotypus in Herbario Ustil. Vánky, HUV 15940:

Sori in foliis puncta rotundata, primo pallide viridia, serius flavida usque pallide brunnea, diametro 0,5–1,5 mm formantes. *Sporae* subglobosae, ovoideae, ellipsoidales usque parum irregulares, 9–13 x 10,5–16 µm, flavae; pariete bistratoso, parum inaequaliter crasso, 1,5–2,5(–3) µm, levi; contentu sporae homogeneo. *Anamorpha* sicut lamina alba lateris abaxialis folii, maculo congruens.

Sori (Fig. 45) in the leaves forming rounded, first pale green, later yellowish to pale brown spots, 0.5–1.5 mm in diameter. *Spores* (Fig. 43) subglobose, ovoid, ellipsoidal to slightly irregular, 9–13 x 10.5–16 µm, yellow; wall two-layered, slightly unevenly thick, 1.5–2.5(–3) µm, smooth; spore content homogeneous. *Anamorph* as a white cover on the abaxial side of the leaves within the spots.

On Compositae (subfam. Asteroideae): *Coreopsis borianiana* Sch. Bip. ex Schweinf.; N.E. Africa (Ethiopia). Known only from the type collection.

2. *Entyloma aeschynomenis* Vánky, sp. nov.

Typus in matrice *Aeschynomene indica* L., Nyasaland [= Malawi], Limbe Distr., banks of Luchenza River at Gongoti, 18.II.1950, leg. P. O. Wiehe 546. Holotypus in IMI 44448, isotypus in Herbario Ustil. Vánky, HUV 19509.

Sori in foliolis puncta circularia usque elliptica, nonnunquam a vena mediana limitata, pallide flavidobrunnea, plana, 0,5–1 x 1–2 mm, vel contextu longiora formantes. *Sporae* in telis matricalibus dispersae, solitariae, globosae, ovoideae usque parum irregulares, 8–10,5 x 9,5–12 µm, subhyalinae usque pallide flavae; pariete aequaliter crasso, cca. 0,5 µm, levi; contextu leniter granuloso. *Anamorpha* non observata.

Sori (Fig. 46) in the leaflets forming circular to elliptical, sometimes by the middle vein delimited, pale yellowish-brown, flat spots, 0.5–1 x 1–2 mm, or longer by confluence. *Spores* (Fig. 44) dispersed in the host tissue, solitary, globose, ovoid to slightly irregular, 8–10.5 x 9.5–12 µm, subhyaline to pale yellow; wall evenly thick, c. 0.5 µm, smooth; content finely granular.

On Leguminosae: *Aeschynomene indica* L.; C. Africa (Malawi; see the type).

3. *Entyloma medicaginis* Vánky, sp. nov.

Typus in matrice *Medicago polymorpha* L., Pakistan, Dadu Distr., Bubák, 2.II.1968, S. Ahmad. Holotypus in IMI 134710, isotypus in HUV 17688.

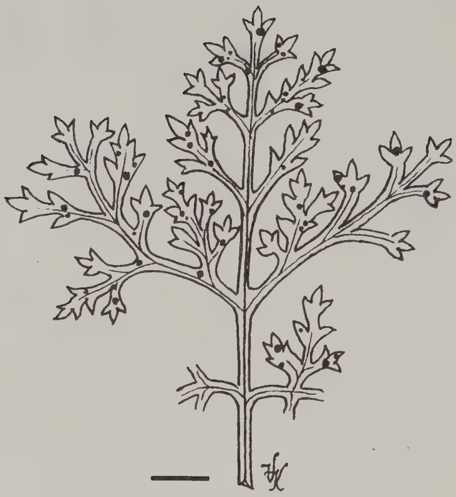
Sori in foliis maculas parvas, rotundas, albidas usque brunneas, 0,2–1 mm diametro formantes. *Sporae* in telis plantae nutrientis inclusae, solitariae vel in catervis, globosae, ovoideae vel parum irregulares cum latere uno depresso, 11–14(–15) x 12–16,5 µm, pallide flavidobrunneae; pariete levi, bistratoso strato interno aequali, 0,8–1 µm crasso, strato exteriore inaequali, apparenter nullo usque 1(–1,5) µm crasso. *Anamorpha* praesens.

Sori (Fig. 47) in the leaves forming small, rounded, whitish to brown spots, 0.2–1 mm in diameter. *Spores* (Fig. 50) embedded in the host tissue, solitary or in groups, globose, ovoid or slightly irregular with a flattened side, 11–14(–15) x 12–16.5 µm, pale yellowish-brown; wall smooth, two layered, inner layer even, 0.8–1 µm thick, outer layer uneven, from apparently absent to 1(–1.5) µm thick. *Anamorph* present on the abaxial side of the leaves within the spots.

On Leguminosae: *Medicago polymorpha* L.; S. Asia (Pakistan; see the type).

Key to the *Entyloma* species of Leguminosae

1. Spores 12–16(–18) µm long..........2
– Spores 9.5–13 µm long..........3
2. Sori 1–3 mm long, with indefinite margins. Spore wall c. 1 µm thick. Anamorph absent. On *Lathyrus*..........*E. feurichii*
– Sori 0.2–1 mm long, with definite margins. Spore wall 1–2 µm thick. Anamorph present. On *Medicago*..........*E. medicaginis*
3. Sori 1–2 mm long or longer, flat. Spore wall c. 0.5 µm thick. Anamorph absent. On *Aeschynomene*..........*E. aeschynomenis*
– Sori up to 1 mm long, slightly raised. Spore wall c. 1 µm thick. Anamorph present. On *Melilotus*..........*E. meliloti*



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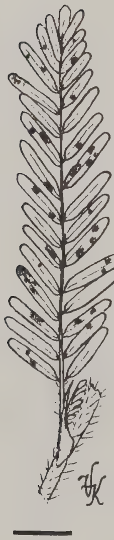

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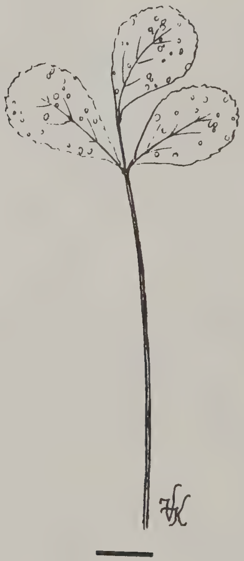

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Fig. 45. Sori of *Entyloma coreopsis* Vánky on the leaves of *Coreopsis borianiana* Sch. Bip. (type).

Fig. 46. Sori of *Entyloma aeschynomenis* Vánky on the leaflets of *Aeschynomene indica* L. (type).

Fig. 47. Sori of *Entyloma medicaginis* Vánky on the leaves of *Medicago polymorpha* L. (type). Bars = 1cm.

A NEW *DOASSANSIOPSIS* ON *NYMPHOIDES* (MENYANTHACEAE)

Doassansiopsis nymphoides Vánky, **sp. nov.**

Typus in matrice *Nymphoides rautaneni* (N. E. Br.) A. Raynal, Zambia, Southern Province, 130 km SE urbe Kafue, 2 km N "Sandy Beach Camping" ad lacum Kariba, 16°27'54" S, 28°40'29" E, alt. cca. 520 m.s.m., 28.IV.2001, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19623, isotypi in Vánky, Ust. exs. no. 1126.

Sori sicut maculae rotundae foliorum, in diametro 1–4 mm, confluentes eorum majores, irregulares, in latere adaxiali folii deplanati, flavi, in latere abaxiali, in aqua immerso plus-minus pustulares, brunnei, punctis parvis brunneis: glomerulis sporarum in telis plantae nutrientis immersis. *Glomeruli sporarum* forma et magnitudine varii, globoidei, ellipsoidales, elongati, irregulares, nonnunquam deplanati, 180–320 x 220–400(–440) μm, brunnei, e massa centrali cellularum pseudoparenchymaticarum sterilium fungalium, strato sporarum radialiter elongatarum et strato externo cellularum minorum, sterilium circumdata compositi. *Sporae* forma at magnitudine variae, polyedrice irregulares, elongatae, aliquando ad extremum alterum latiores, 4–12 x 15–26 μm, pallide flavae; pariete tenui, cca. 0,5 μm, aequaliter crasso, levi. *Cellulae steriles pseudoparenchymaticae* polyedrice irregulares, magnitudine nimie variae, magnae in parte centrali glomerulorum (usque ad 16 x 20 μm), minores ad marginem versus (prope sporas 3 x 5 μm), hyalinae, vacuae; pariete tenui (cca. 0,5 μm), levi. *Cellulae steriles strati externi* forma et magnitudine variae, in lateribus contactis cum sporis deplanatae, saepe elongatae et rotundae, aspectum papillatum surficiei glomerulorum sporarum producentes, a 3 x 4 μm usque 8 x 11 μm, hyalinae, vacuae; pariete aequali, cca. 0,5 μm crasso, levi.

Sori (Fig. 48) as rounded leaf spots, 1–4 mm in diameter, or larger, irregular by confluence, flattened, yellow on the adaxial side, more or less pustular, brown on the abaxial side, immersed in the water, with small, brown dots, the spore balls embedded in the host tissue. *Spore balls* (Fig. 51) variable in shape and size, globoid, ellipsoidal, elongated, irregular, sometimes flattened, 180–320 x 220–400(–440) μm, brown, composed of a central mass of pseudoparenchymatous fungal sterile cells, surrounded by a layer of radially elongated spores and an external layer of smaller sterile cells. *Spores* (Fig. 51 s) variable in shape and size, polyhedrally irregular, elongated, sometimes widened on one end, 4–12 x 15–26 μm, pale yellow; wall thin, c. 0.5 μm, evenly thick, smooth. *Sterile, pseudoparenchymatous cells* (Fig. 51 p) polyhedrally irregular, extremely variable in size, large in the central part of the ball (up to 16 x 20 μm), smaller towards the periphery (close to the spores as small as 3 x 5 μm), hyaline, empty; wall thin (c. 0.5 μm), smooth. *External layer of sterile cells* (Fig. 51 c) variable in shape and size, flattened on the contact sides with the spores, often elongated and rounded giving a papillate aspect to the surface of the spore ball, from 3 x 4 μm to 8 x 11 μm, hyaline, empty; wall even, c. 0.5 μm thick, smooth.

On Menyanthaceae (Gentianales): *Nymphoides rautaneni* (N. E. Br.) A. Raynal; C. Africa (Zambia). Known only from the type collection

The Menyanthaceae comprise five genera (Melchior, ed., 1964:410). Smut fungi have been reported only on *Nymphoides* (*Limnanthemum*). These are: 1. *Burrillia decipiens* (Winter) G. P. Clinton (1902:154), type on *Limnanthemum lacunosum* (Vent.) Griseb. (*Nymphoides lacunosum* (Vent.) Kuntze), USA, in which the spore balls are lacking a cortex, and 2. *Burrillia limnanthemi* Ciferri (1931:22), type on *Limnanthemum humboldtianum* (H. B. K.) Grieseb., Dominican Republic. *Burrillia* is characterised by spore balls in which the spores are scattered or situated more or less peripheral in a pseudoparenchymatic tissue, and lacking a cortex. According to Ciferri (1931:22), in *B. limanthemi* the spore balls are composed of a cortex of fertile spores and a central mass of sterile cells; the spores are elongated, subpolyhedrical, yellowish, smooth, 15–19 x 4–6 µm. This description fits better with the characters of a *Doassansiopsis*, but in this genus the spores are additionally surrounded by a cortical layer of small sterile cells. Ciferri does not mention the presence of such a cortical layer (which often is difficult to see). A study of the type specimen is necessary to elucidate the generic position of this smut. Unfortunately, it is not known where the type specimen is deposited. It is not in BPI, where the collection of Ciferri is preserved. However, it seems that the spore measurements also differentiate *Doassansiopsis nymphoides* from "*Burrillia*" *limnanthemi*.

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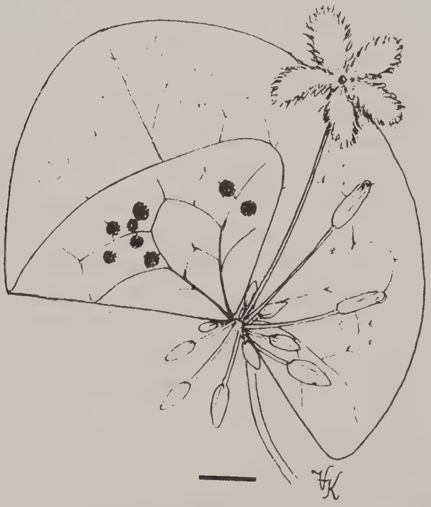

Fig. 48. Sori of *Doassansiopsis nymphoides* Vánky, as leaf spots on the adaxial side and pustules on the abaxial side on a leaf of *Nymphoides rautaneni* (N. E. Br.) A. Raynal. (type). Bar = 1 cm.

A NEW *AURANTIOSPORIUM* ON *SCLERIA* (CYPERACEAE)

Aurantiosporium scleriae Vánky, sp. nov.

Typus in matrice *Scleria flexuosa* Böckeler (det. K. A. Lye, NLH), Malawi, Northern Province, 98 km NW urbe Mzuzu, 32 km W pag. Rumpi, 10°55'10" S, 33°36'27" E, alt. cca. 1230 m.s.m., 21.IV.2001, leg. C., T. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19629, isotypi in Vánky, Ust. exs. no. 1132. Paratypus: Malawi, Northern Prov., Nyika National Park, 10 km W Chelinda Camp, 10°35'03" S, 33°45'17" E, alt. cca. 2400 m.s.m., 22.IV.2001, leg. C., T. & K. Vánky, HUV 19630.

Sori cladomanias globoideas, diametro cca. 1 cm formantes, e spiculis multis, nimis proliferantibus, sterilibus cum glomerulis sporarum in telis plantae nutrientis spiculorum unacum partis basalis involucrorum floralium immersis producti. Glumae 1–2, maxime externae tantum et pars distalis involucrorum floralium intactae. Maturitate sori telae plantae nutrientis ruptae et massa atra, rubiginosa, granulosopulverea glomerulorum sporarum dispersa. *Glomeruli sporarum* forma et magnitudine varii, subglobosi, ellipsoidales, elongati, plerumque irregulares, (40–)60–120(–180) x (70–)80–170(–210) µm, aurantiacei usque latericii, e sporis plurimis pressu valido separabilibus compositi. *Sporae* forma et magnitudine extraordinarie variae, raro globoideae vel ellipsoidales, plerumque irregulares, subpyramidales vel elongatae (in glomerulis radialiter dispositae), lateribus nonnullis deplanatis, saepe cum papillis 1–3 ad angulos et etiam acie acuto secundum lineam applicationis laterum duorum deplanatorum. Sporae non raro versus centrum glomeruli in apicem acutum attenuatae et in appendicem brevem vel usque 22 µm longum, residuum hyphae sporogeneae prolongatae. Sporae usque 21 µm latae et 12–40 µm longae, citrinae vel pallide aurantiacae Superficies libera sporarum plana vel plus-minus convexa raro usque hemisphaerica, visu superficiali rotundata, subpolyangularice irregularis, 5–13,5 x 5,5–16 µm. Paries sporarum bistratosus, endospora aequalis, 0,5–0,8 µm crassa, exospora crassitudine varia, ab indiscernibili usque ad 3 µm, maxime crassa ad superficiem liberam sporae et in angulis, levis.

Sori (Fig. 56) forming globoid witches' brooms of c. 1 cm in diameter, consisting of numerous, excessive proliferating sterile spikelets with spore balls produced within the host tissue of the spikelets including the basal part of floral envelopes. Only the outermost 1–2 glumes and the distal part of the floral envelopes are not affected. At maturity, the host tissue ruptures and the dark, rusty-brown, granular-powdery mass of spore balls is scattered. *Spore balls* (Figs. 52, 53) variable in shape and size, subglobose, ellipsoidal, elongated, usually irregular, (40–)60–120(–180) x (70–)80–170(–210) µm, orange-yellow to brick-red, composed of a great number of spores which separate at hard pressure. *Spores* (Figs. 49, 52, 53) extremely variable in shape and size, rarely globoid or ellipsoidal, usually irregular, subpyramidal or elongated (arranged radially within the balls), with several flattened sides, often with 1–3 papillae at the angles and also with a sharp edge along the meeting line of two flattened sides. Not rarely the spores are narrowing into an acute tip towards the centre of the ball and prolonging into a short or up to 22 µm long appendage, the remnant of the sporogenous hypha. The spores are up to 21 µm wide and 12–40 µm long, lemon- or pale orange-yellow. Free surface of the spores flat or more or less convex to rarely hemispherical, in surface view rounded, subpolyangularly irregular, 5–13.5 x 5.5–16 µm. Spore wall two-layered, endospore even, 0.5–0.8 µm thick, exospore variable in thickness, from indistinguishable up to 3 µm, thickest at the free surface of the spores and at the angles, smooth.

On *Scleria flexuosa* Böckeler; C. Africa (Malawi). Known only from the type collections.

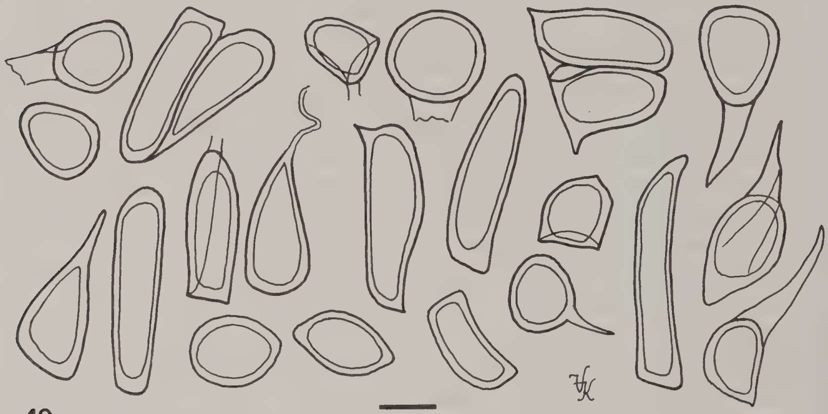

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Fig. 49. Spores of *Aurantiosporium scleriae* Vánky on *Scleria flexuosa* Böckeler (type). Bar = 10 µm

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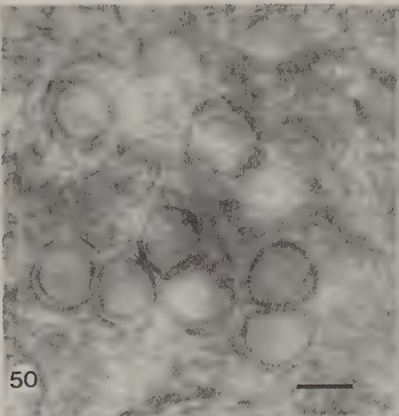
Fig. 50. Spores of *Entyloma medicaginis* Vánky on *Medicago polymorpha* L., in LM (type).

Fig. 51. Part of a spore ball of *Doassansiopsis nymphoides* Vánky, on *Nymphoides rautaneni* (N. E. Br.) A. Raynal. Hand-cut section (type). **c**. cortex of small, sterile cells; **s**. spores; **p**. central mass of pseudoparenchymatous fungal cells.

Figs. 52, 53. Spore balls and spores of *Aurantiosporium scleriae* Vánky on *Scleria flexuosa* Böckeler, in LM and in SEM (type).

Figs. 54, 55. Spores and sterile cells of *Macalpinomyces leptocarydionis* Vánky & C. Vánky on *Leptocarydion vulpiastrum* (De Not.) Stapf, in LM and in SEM (type). Bars = 10 µm.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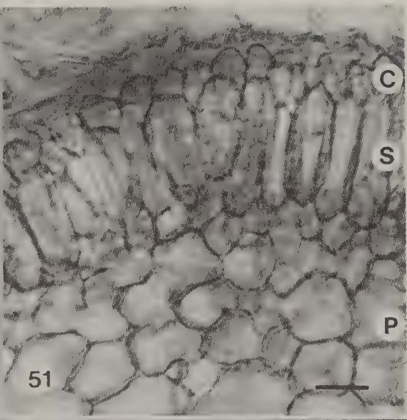
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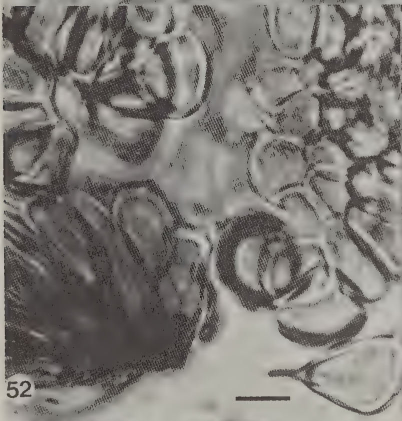
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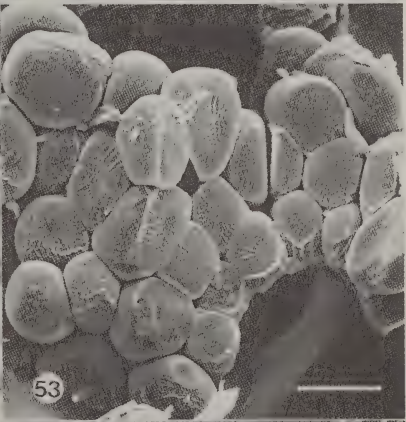
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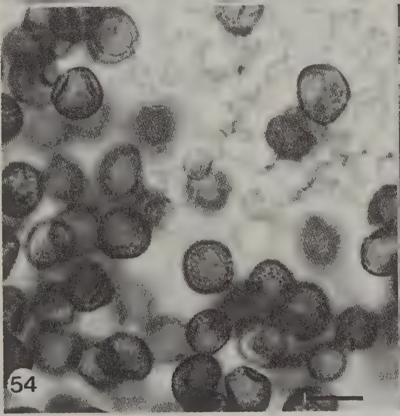
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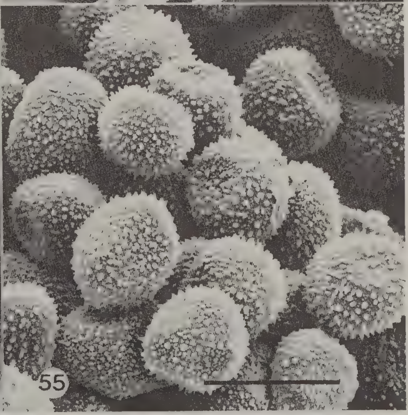
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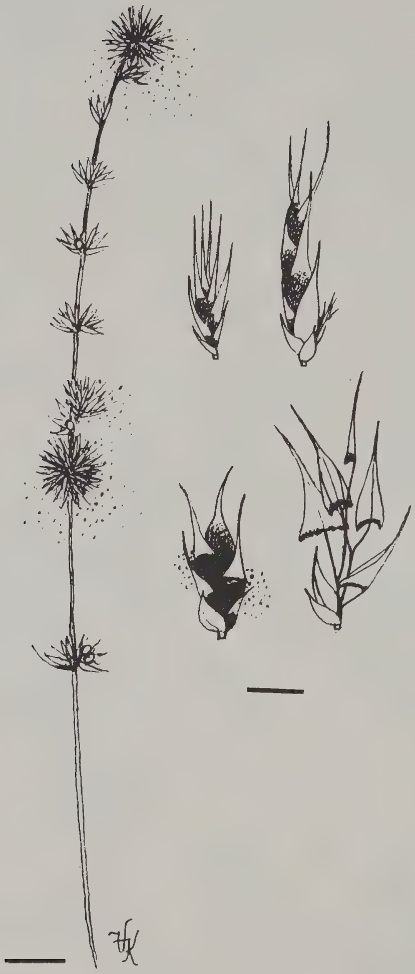

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Fig. 56. Sori of *Aurantiosporium scleriae* Vánky on *Scleria flexuosa* Böckeler, forming globoid witches' brooms composed of numerous infected, sterile spikelets (type). Habit (left), and enlarged four spikelets with sori in different developmental stages (right). After the spore balls are scattered, only the top of the floral envelopes remains, hanging on their vascular strands.

Bars = 1 cm for the habit, 2 mm for detail drawing.

A SMUT FUNGUS OF *LEPTOCARYDION* (GRAMINEAE)

Leptocarydion Stapf is a unispecific genus in Eastern and Southern Africa, belonging to the subfam. Chloridoideae, tribe Eragrostideae, subtribe Eleusininae (Clayton & Renvoize, 1986:213). No smut fungus has yet been reported on it. A most inconspicuous smut fungus was recently collected in Zambia on *L. vulpiastrum*:

Macalpinomyces leptocarydionis Vánky & C. Vánky, **sp. nov.**

Typus in matrice *Leptocarydion vulpiastrum* (De Not.) Stapf, Zambia, Southern Province, 126 km SE urbe Kafue, 8 km N pag. Siavonga, 16°29'32" S, 28°45'33" E, alt. cca. 670 m.s.m., 30.IV.2001, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19631, isotypi in Vánky, Ust. exs. no. 1137.

Sori in ovariis nonnullis inflorescentiae eiusdem, plurimi eorum involucris floralibus omnio occulti, fusiformes vel elongato-ovoidei, cum apice acuto vel subacuto, nonnunquam pars distalis caryopsidum intacte manens, 0,3–0,7 x 1–2 mm, membrana primo olivaceobrunnea, serius brunnea, e pericarpio et cellulis fungalibus formata cooperti. Massa sporarum atrobrunnea, semiagglutinata usque pulverea. *Sporae* forma et magnitudine variae, subglobosae, ellipsoidales, elongatae, plerumque plus-minus irregulares, subpolyedricae, pyriformes vel lobatae, 8–11(–12) x 9–14,5 µm, flavidobrunneae; pariete aequaliter crasso (cca. 0,5 µm), satis dense verruculoso-echinulato; imago obliqua sporarum a paene levi usque leniter serrulata. *Cellulae steriles* variae, globosae, ovoideae, ellipsoidales, 4–7 x 4,5–10 µm, hyalinae, in catervis irregularibus vel singulae; pariete aequali, cca. 0,5 µm crasso, levi.

Sori (Fig. 57) in some ovaries of an inflorescence, most sori completely hidden by the floral envelopes, fusiform or oblong-ovoid with acute or subacute tip, sometimes the distal part of the caryopses remains intact, 0.3–0.7 x 1–2 mm, covered by a first olivaceous-green later brown membrane formed of the pericarp and fungal cells. Spore mass dark brown, semiagglutinated to powdery. *Spores* (Figs. 54, 55) variable in shape and size, subglobose, ellipsoidal, elongated, usually more or less irregular, subpolyhedral, pyriform or lobed, 8–11(–12) x 9–14.5 µm, yellowish-brown; wall evenly thick (c. 0.5 µm), rather densely verruculose-echinulate; spore profile from nearly smooth to finely serrulate. *Sterile cells* (Fig. 54) variable, globose, ovoid, ellipsoidal, 4–7 x 4.5–10 µm, hyaline, in irregular groups or single; wall even, c. 0.5 µm thick, smooth.

On *Leptocarydion vulpiastrum* (De Not.) Stapf; C. Africa (Zambia). Known only from the type collection.

A SMUT FUNGUS ON *POGONARTHRIA* (GRAMINEAE)

Pogonarthria Stapf, is a genus of four species in tropical and south Africa. It belongs to the subfam. Chloridoideae, tribe Eragrostideae, subtribe Eleusininae (Clayton & Renvoize, 1986:220). No smut fungus has yet been reported on it. An inconspicuous smut fungus was collected in Zambia and Zimbabwe on *Pogonarthria squarrosa*:

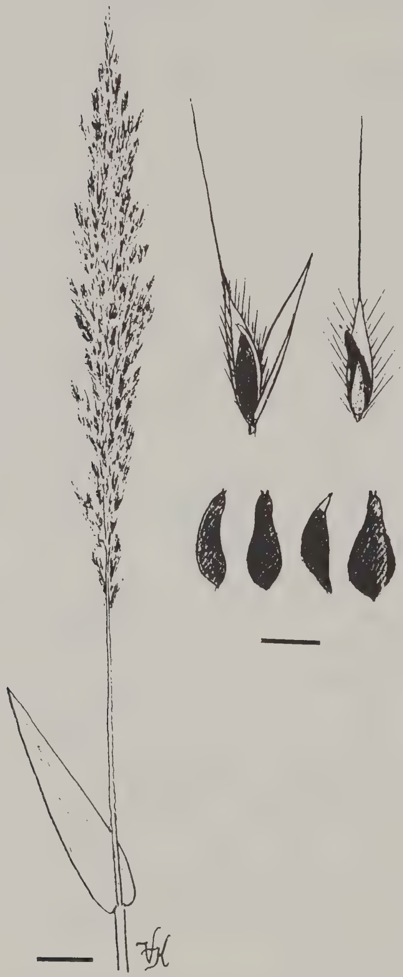

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Fig. 57. Sori of *Macalpinomyces leptocarydionis* Vánky & C. Vánky in some ovaries of an inflorescence of *Leptocarydion vulpiastrum* (De Not.) Stapf (type). Habit, and some sori enlarged, with and without floral envelopes.
Bars = 1 cm for the habit, 1 mm for the detail drawings.

Macalpinomyces pogonarthriae Vánky & C. Vánky, **sp. nov.**
Typus in matrice *Pogonarthria squarrosa* (Roem. & Schult.) Pilger, Zambia, Southern Province, 135 km NE urbe Livingstone, 25 km E pag. Kalomo, 16°59'59" S, 26°43'05" E, alt. cca. 1250 m.s.m., 12.IV.2001, leg. C., T. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19675. Isotypi in Vánky, Ust. exs. no. 1131. Paratypi: Zimbabwe, Matabeleland North Prov., 3.5 km E Binga–Chilala intersection, 17°37'50" S, 27°25'02" E, alt. cca. 600 m.s.m., 15.III.1999, leg. C. & K. Vánky, HUV 19099; Zambia, Southern Province, 46 km NNE urbe Livingstone, 17°31'10" S, 25°59'58" E, alt. cca. 1040 m.s.m., 14.IV.2001, leg. C., T. & K. Vánky, HUV 19676; Southern Province, 23 km SE urbe Kafue, 15°53'17" S, 28°19'35" E, alt. cca. 930 m.s.m., 28.IV.2001, leg. C. & K. Vánky, HUV 19677.

Sori in ovariis nonnullis inflorescentiae eiusdem, inconspicui, globoidei vel ovoidei cum apice brevi, acuto, 0,5–1 x cca. 1 mm, membrana primo viridi serius brunnea cooperti, qua irregulariter rupta massam sporarum atrobrunneam, semiagglutinatam usque pulveream et catervas cellularum sterilium ostendentes. Columella deest. *Sporae* in catervis irregularibus vel singulae, globosae, subglobosae vel ovoideae, raro parum irregulares, 5–7 x 5,5–9(–10) µm, pallide flavidobrunneae; pariete aequaliter crasso, cca. 0,5 µm, sparse, conspicue echinulato, propter hoc imago obliqua sporae bene affecta. *Cellulae steriles* paucae, in catervis irregularibus, cellulae singulae globosae, ovoideae vel parum irregulares, 3–6,5 x 3,5–8 µm, hyalinae; pariete aequali, cca. 0,5 µm crasso, levi, contentus homogeneus.

Sori (Fig. 58) in some ovaries of an inflorescence, inconspicuous, globoid or ovoid with a short acute tip, 0.5–1 x c. 1 mm, covered by a first green later brown membrane which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of spores and groups of sterile cells. Columella lacking. *Spores* (Figs. 59, 60) in irregular groups or single, globose, subglobose or ovoid, rarely slightly irregular, 5–7 x 5.5–9(–10) µm, light yellowish-brown; wall evenly thick, c. 0.5 µm, sparsely, evidently echinulate which just affects the spore profile. *Sterile cells* (Figs. 59, 60) few, in irregular groups, single cells globose, ovoid or slightly irregular, 3–6.5 x 3.5–8 µm, hyaline; wall even, c. 0.5 µm thick, smooth, content homogenous.

On *Pogonarthria squarrosa* (Roem. & Schult.) Pilger; C. & S. Africa (Zambia, Zimbabwe). Probably not rare but easily overlooked.

NEW *MACALPINOMYCES* SPECIES ON ARUNDINELLEAE (GRAMINEAE)

Loudetia, *Trichopteryx*, *Tristachya* and *Zonotriche* are closely related genera in the tribe Arundinelleae, subfam. Panicoideae. Five *Macalpinomyces* species are known on them, all from Africa: **1**. *M. loudetiae* (Viennot-Bourgin) Vánky on *Loudetia arundinacea* (Hochst. ex A. Rich.) Steudel, and *L. flavida* (Stapf) C. E. Hubb., **2**. *M. simplex* Vánky on *Loudetia simplex* (Nees) C. E. Hubb., **3**. *M. trichopterygis* Vánky & C. Vánky on *Trichopteryx dregeana* Nees,

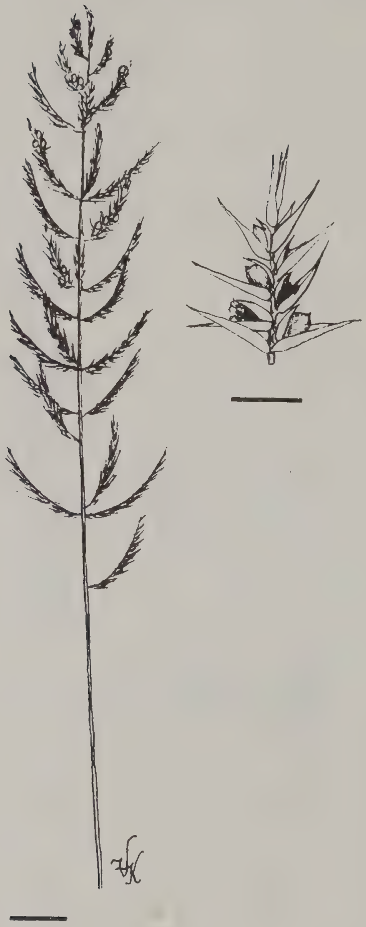

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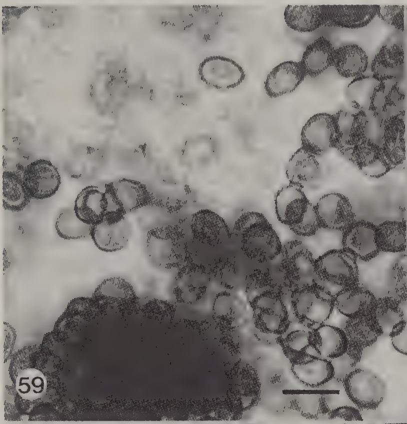
Fig. 58. Sori of *Macalpinomyces pogonarthriae* Vánky & C. Vánky in the ovaries of *Pogonarthria squarrosa* (Roem. & Schult.) Pilger (type). Habit and enlarged some sori, partly hidden by the floral envelopes.
Bars = 1 cm for the habit, 2 mm for the detail drawing.

Figs. 59, 60. Spores and sterile cells of *Macalpinomyces pogonarthriae* Vánky & C. Vánky on *Pogonarthria squarrosa* (Roem. & Schult.) Pilger, in LM and in SEM (type).

Figs. 61, 62. Spores of *Macalpinomyces magicus* Vánky on *Loudetia flavida* (Stapf) C. E. Hubb., in LM and in SEM (type).

Figs. 63, 64. Spores and sterile cells of *Macalpinomyces nodiglumis* Vánky on *Tristachya nodiglumis* K. Schum., in LM and in SEM (type). Bars = 10 μm.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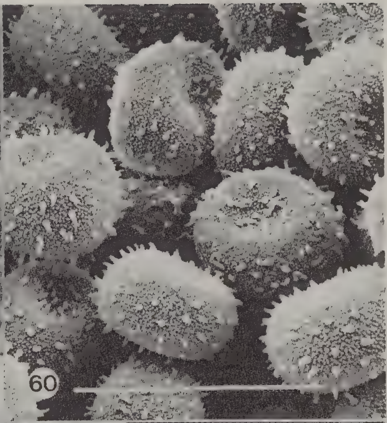
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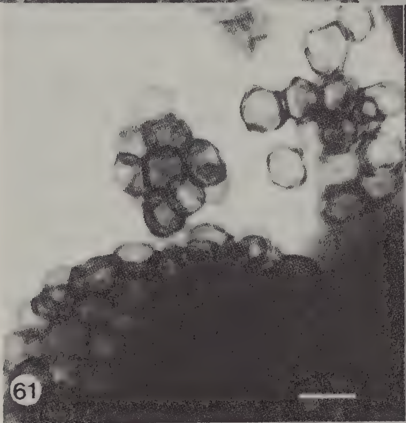
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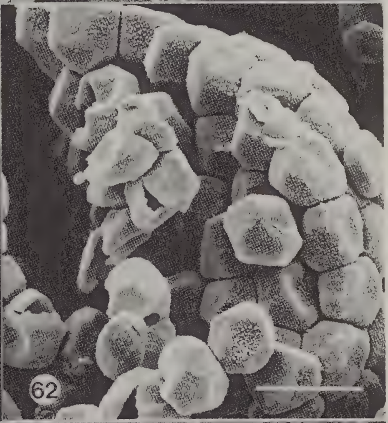
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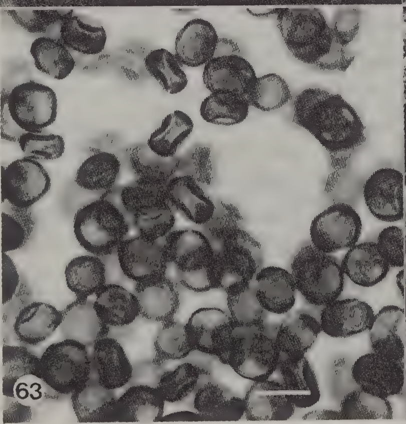
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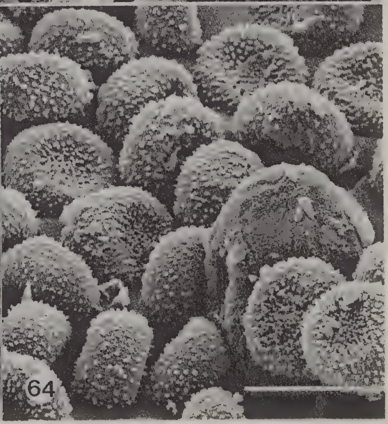
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4. *M. tristachyae* Vánky & C. Vánky on *Tristachya leucothrix* Nees, and 5. *M. zonotriches* Vánky, on *Zonotriche inamoena* (K. Schum.) W. D. Clayton. Two additional, new *Macalpinomyces* species, collected recently in Central Africa are:

Macalpinomyces magicus Vánky & T. Vánky, **sp. nov.**

Typus in matrice *Loudetia flavida* (Stapf) C. E. Hubb., Zambia, Lusaka Province, 124 km ENE urbe Lusaka, 15°08'59" S, 29°21'45" E, alt. cca. 1035 m.s.m., 17.IV.2001, leg. T., C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19647, isotypi in Vánky, Ust. exs. no. 1130. Paratypus: Southern Province, 75 km ESE urbe Kafue, Chirundu Fossil Forest, 16°01'44" S, 28°42'12" E, alt. cca. 490 m.s.m., 28.IV.2001, leg. C. & K. Vánky, HUV 19648, BPI, IMI 386802.

Sori sicut cladomaniae caulium, ad nodos evoluti, e tubulis longis, multis, a spiculis inflorescentiae debilis, refertae, distortae processis compositi. Tubuli pubescentes, primo virides, serius brunnei, 0,7–1 x 30–130 mm, maturi ab apice eorum longitudinaliter fissi, torti convertentes, et massa nigrobrunnea pseudoglomerulorum sporarum cum cellulis sterilibus intermixtis dispersa. Plerumque una vel raro duae cladomaniae eiusdem caulis inflorescentiam plus-minus normalem, terminalem ferentis ortae. *Pseudoglomeruli sporarum* globosi, ovoidei, elongati vel irregulares, 25–70 x 30–80 µm, atro olivaceobrunnei usque subopaci, e sporis multis, facile dissolutis compositi. *Sporae* subpolyedrice irregulares, 6,5–9 x 8–12 µm, olivaceobrunneae; pariete inaequaliter crasso, 0,5–1 µm, in angulis maxime incrassato, conspicue levi usque valde subtiliter punctato; imago obluqua sporarum levis. *Cellulae steriles* in catervis irregularibus vel singulae, globosae, subglobosae usque ovoideae, magnitudine variae, 4–12 x 4–12 µm, hyalinae; pariete 0,5–1,5 µm crasso, levi.

Sori (Fig. 65) as witches' brooms on the stems, at the nodes, composed of numerous long tubes starting from spikelets of a stunted, congested, deformed inflorescence. The tubes are pubescent, first green, later brown, 0.7–1 x 30–130 mm, at maturity they split longitudinally from their apex, become twisted and the blackish-brown mass of pseudo spore balls intermixed with numerous sterile cells are scattered. Usually one, rarely two witches' brooms are present on a stem, which produce a more or less normal, terminal inflorescence. *Pseudo spore balls* (Figs. 61, 62) globose, ovoid, elongated or irregular, 25–70 x 30–80 µm, dark olivaceous-brown to subopaque, composed of numerous spores which separate easily. *Spores* (Figs. 61, 62) subpolyhedrally irregular, 6.5–9 x 8–12 µm, olivaceous-brown; wall unevenly thick, 0.5–1 µm, thickest at the angles, apparently smooth to extremely finely punctate; spore profile smooth. *Sterile cells* (Figs. 61, 62) in irregular groups or single, globose, subglobose to ovoid, variable in size, 4–12 x 4–12 µm, hyaline; wall 0.5–1.5 µm thick, smooth.

On *Loudetia flavida* (Stapf) C. E. Hubb.; C. Africa (Zambia). Known from several collections.

Etymology: *magicus* (Latin) = magician, referring to the production of witches' brooms.

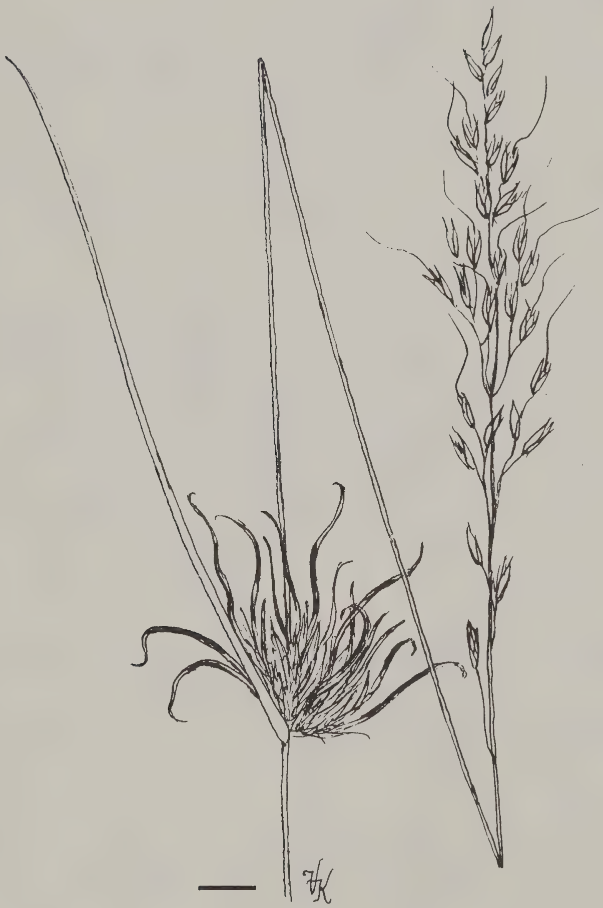

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Fig. 65. Sori of *Macalpinomyces magicus* Vánky & T. Vánky, forming witches' broom on the stem of *Loudetia flavida* (Stapf) C. E. Hubb. (type). Bar = 1 cm.

Macalpinomyces nodiglumis Vánky, sp. nov.

Typus in matrice *Tristachya nodiglumis* K. Schum., Zambia, Lusaka Province, 124 km ENE Lusaka, 15°08'59" S, 29°21'45" E, alt. cca. 1035 m.s.m., 17.IV.2001, leg. T., C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19644, isotypi in Vánky, Ust. exs. no. 1139. Paratypus: Lusaka Province, 169 km ENE Lusaka, 15°04'10" S, 29°45'22" E, alt. cca. 960 m.s.m., 17.IV.2001, leg. T., C. & K. Vánky, HUV 19645.

Sori ovariis nonnullis valde hypertrophitis inflorescentiae eiusdem, fusiformes, 1,5–2 x 20–50 mm, membrana crassa, pubescenti cooperti, qua matura longitudinaliter rupta massam sporarum atrobrunneam, semiagglutinatam usque pulveream, cum cellulis sterilibus pergrandibus intermixtam ostendentes. *Sporae* globoideae vel subpolyedrice irregulares, lateraliter parum compressae (5,5–8 µm latae), in visu faciali 7–9,5 x 7–10,5 µm, rufobrunneae; pariete 0,5–1 µm crasso, leniter, dense verruculoso-echinulato; imago obliqua sporarum levis usque leniter serrulata. *Cellulae steriles* in catervis parvis vel singulae, subglobosae, ovoideae vel parum irregulares, 10–20 x 11–26 µm, hyalinae; pariete 1–3 µm crasso, levi.

Sori (Fig. 66) in some, much hypertrophied ovaries of an inflorescence, fusiform, 1.5–2 x 20–50 mm, covered by a thick, pubescent membrane which at maturity splits longitudinally disclosing the dark brown, semiagglutinated to powdery mass of spores intermixed with giant sterile cells. *Spores* (Figs. 63, 64) globoid or subpolyhedrally irregular, laterally slightly compressed (5.5–8 µm wide), in facial view 7–9.5 x 7–10.5 µm, reddish-brown; wall 0.5–1 µm thick, finely, densely verruculose-echinulate; spore profile smooth to finely serrulate. *Sterile cells* (Figs. 63, 64) in small groups or single, subglobose, ovoid or slightly irregular, 10–20 x 11–26 µm, hyaline; wall 1–3 µm thick, smooth.

On *Tristachya nodiglumis* K. Schum.; C. Africa (Zambia). Known from several collections.

Key to the *Macalpinomyces* species of *Loudetia, Trichopterix, Tristachya* and *Zonotriche*

1. Sori in the distal part of the stems as long tubes, later as twisted bands............2
– Sori elsewhere 4
2. Spores 7–9 µm long. ....*M. tristachyae*
– Spores larger...3
3. Spores 8–12 µm long. Wall of sterile cells 2.5–3 µm thick .....*M. trichopterygis*
– Spores 9.5–15 µm long. Wall of sterile cells 1–2 µm thick .... *M. simplex*
4. Sori on the stems, forming witches' brooms at the nodes.................*M. magicus*
– Sori elsewhere, not forming witches' brooms 5
5. Sori comprise the central part of the spikelets, tubular, filiform, later as twisted or looped bands. Sterile cells up to 13 µm long ....*M. loudetiae*
– Sori in the ovaries. Sterile cells up to 26–30 µm long 6
6. Spores 5–9 µm long. Wall of sterile cells 4–7 µm thick .... *M. zonotriches*
– Spores 7–10.5 µm long. Wall of sterile cells 1–3 µm thick ....*M. nodiglumis*

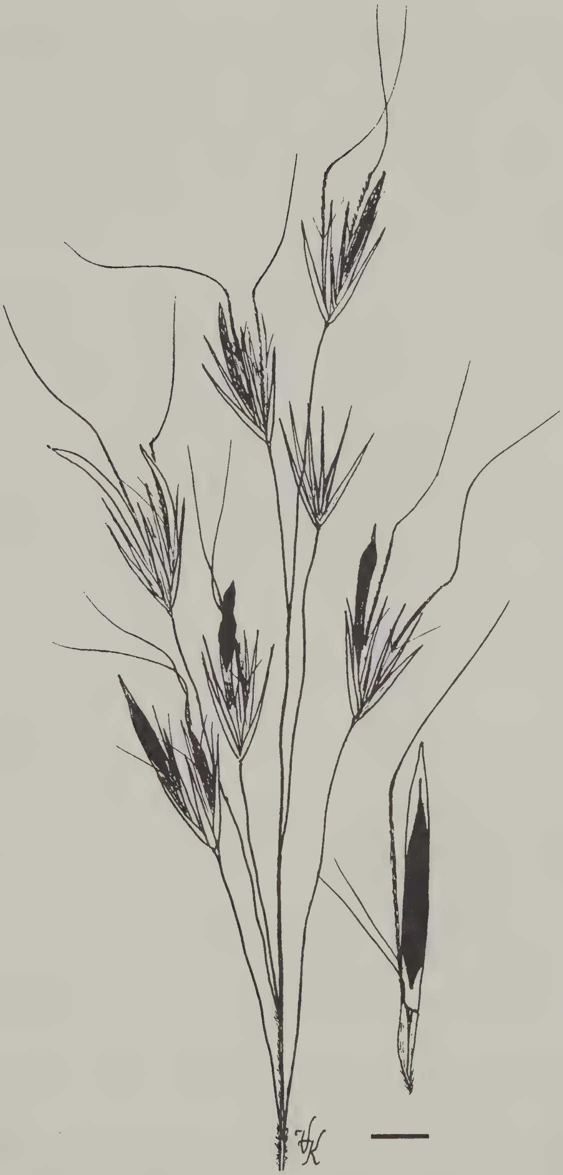

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Fig. 66. Sori of *Macalpinomyces nodiglumis* Vánky in the hypertrophied ovaries of *Tristachya nodiglumis* K. Schum. (type).
Bars = 1 cm for the habit, 5 mm for the detail drawing.

A SMUT FUNGUS ON *STEREOCHLAENA* (GRAMINEAE)

Stereochlaena Hack. is a genus of 5 species in Africa belonging to the subfam. Panicoideae, tribe Paniceae, subtribe Digitariinae (Clayton & Renvoize, 1986:198). No smut fungus has yet been reported on it. A smut fungus, collected on *Stereochlaena cameronii* in Zambia was thought to be a new species. However, it turned out that it is known under the name of *Ustilago chloridionis* L. Ling on *Chloridion cameronii*. The fungus belongs to the genus *Macalpinomyces*. Its transfer into this genus and an amended description of it is given below.

Macalpinomyces chloridionis (L. Ling) Vánky, **comb. nov.**

Basionym: *Ustilago chloridionis* L. Ling, Lloydia 16:180, 1953. Type on *Chloridion cameronii* Stapf (= *Stereochlaena cameronii* (Stapf) Pilger), Nyasaland (= Malawi), Northern Province, Vipya plateau, X.1950, G. Jackson. Holotype in IMI 44452, isotype in HUV 17806.

Sori in ovariis nonnullis inflorescentiae eiusdem, inconspicui, integumentis floralibus occulti, ellipsoidales, cca. 0,5–1 x 2–2,5 mm, membrana tenui, brunneola cooperti, qua irregulariter rupta massam atrobrunneam granuloso-pulveream sporarum cum cellulis sterilibus intermixtam ostendentes. Columella nulla. *Sporae* in pseudoglomerulis irregularibus sporarum vel singulae, subpolyedrice irregulares, 6–8(–9) x 6,5–10,5 µm, flavidobrunneae; pariete aequaliter crasso (cca. 0,5 µm), subtiliter, dense echinulato; imago obliqua sporarum serrulata. *Cellulae steriles* subglobosae, ellipsoidales vel parum irregulares, 8–15 x 9–18 µm, hyalinae usque pallide flavae; pariete 0,5–1 µm crasso, levi.

Sori (Fig. 67) in some ovaries of an inflorescence, inconspicuous, hidden by the floral envelopes, ellipsoidal, c. 0.5–1 x 2–2.5 mm, covered by a thin, brownish membrane which ruptures irregularly disclosing the dark brown, granular-powdery mass of spores intermixed with sterile cells. Columella lacking. *Spores* (Figs. 69, 70) in irregular groups of pseudo spore balls or single, subpolyhedrally irregular, 6–8(–9) x 6.5–10.5 µm, yellowish-brown; wall evenly thick (c. 0.5 µm), finely, densely echinulate; spore profile serrulate. *Sterile cells* (Figs. 69, 70) subglobose, ellipsoidal or slightly irregular, 8–15 x 9–18 µm, hyaline to pale yellow; wall 0.5–1 µm thick, smooth.

On *Stereochlaena cameronii* (Stapf) Pilger; C. Africa (Malawi and Zambia).

A NEW SMUT FUNGUS ON *SCHIZACHYRIUM* (GRAMINEAE)

Schizachyrium Nees is a genus of c. 60 species throughout the tropics. It belongs to the subfam. Panicoideae, tribe Andropogoneae, subtribe Andropogoninae (Clayton & Renvoize, 1986:352). Only one smut fungus was reported on it: *Sporisorium guaraniticum* (Speg.) Vánky, on *Schizachyrium condensatum* (H. B. K.) Desv., from Paraguay. A different smut fungus was recently collected in Zambia:

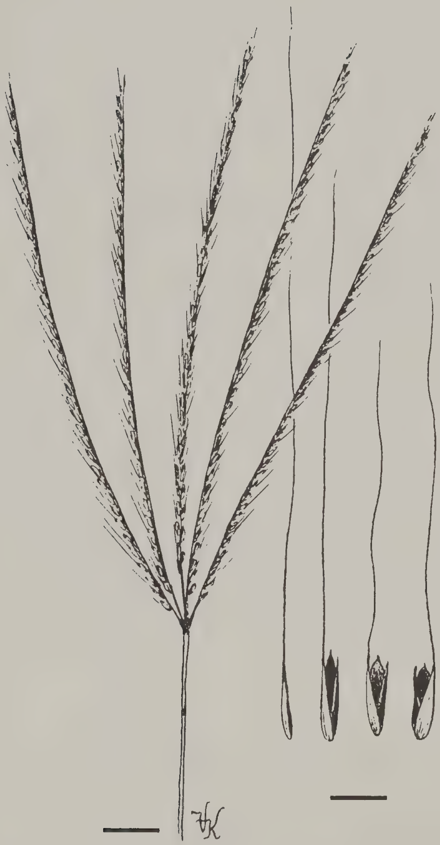

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Fig. 67. Sori of *Macalpinomyces chloridionis* (L. Ling) Vánky in the ovaries of *Stereochlaena cameronii* (Stapf) Pilger (HUV 19652). Habit and enlarged a healthy and three infected ovaries, hidden by the lemma and palea.
Bars = 1 cm for the habit, 2 mm for the detail drawings.

Sporisorium schizachyrii Vánky, sp. nov.

Typus in matrice *Schizachyrium exile* (Hochst.) Pilger, Zambia, Southern Province, 75 km ESE urbe Kafue, Chirundu Fossil Forest, 16°01'44" S, 28°42'12" E, alt. cca. 490 m.s.m., 28.IV.2001, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19654, isotypi in Vánky, Ust. exs. no. 1128.

Sori in spiculis sessilibus hermaphroditis, cylindrici, cca. 1 x 6–10 mm, peridio pallide flavidobrunneo cooperti, quo mature in taeniis nonnullis fisso, massam atrobrunneam, granulosopulveream glomerulorum sporarum, columellam simplicem, centralem circumdantem dispergentes. *Glomeruli sporarum* forma et magnitudine varii, subglobosi, ovoidei, ellipsoidales, elongati, irregulares, 30–80 x 35–160(–200) µm, atro-flavidobrunnei, e sporis multis, pressu separabilibus compositi. *Sporae* ellipsoidales usque subpolyedrice irregulares, 7–9 x 8–10,5 µm, externae earum atro-flavidobrunneae; pariete 0,5–1 µm crasso, in superficie libera dense, prominenter echinulato. Sporae internae subhyalinae usque pallide flavidobrunneae; pariete tenui (usque ad 0,5 µm), conspicue levi usque valde subtiliter punctato. *Cellulae steriles* non observatae.

Sori (Fig. 68) in the sessile, hermaphrodite spikelets, cylindrical, c. 1 x 6–10 mm, covered by a pale yellowish-brown peridium which early splits into several bands and the dark brown, granular-powdery mass of spore balls, surrounding a simple, central columella, are scattered. *Spore balls* (Figs. 71, 72) variable in shape and size, subglobose, ovoid, ellipsoidal, elongated, irregular, 30–80 x 35–160(–200) µm, dark yellowish-brown, composed of numerous spores which separate by pressure. *Spores* (Figs. 71, 72) ellipsoidal to subpolyhedrally irregular, 7–9 x 8–10.5 µm, outer spores dark yellowish-brown, with 0.5–1 µm thick wall, densely, prominently echinulate on the free surface. Inner spores subhyaline to pale yellowish-brown, wall thin (up to 0.5 µm), apparently smooth to very finely punctate. *Sterile cells* not seen.

On *Schizachyrium exile* (Hochst.) Pilger; C. Africa (Zambia). Known only from the type collection.

THE SMUT FUNGI OF *PHRAGMITES* (GRAMINEAE)

Phragmites Adans. is a uniform, cosmopolitan genus of 3–4 species belonging to the subfam. Arundinoideae, tribe Arundineae (Clayton & Renvoize, 1986:182). Smut fungi reported on *Phragmites* are: 1. *Neovossia danubialis* Săvul., 2. *N. iowensis* H. H. Hume & Hodson, 3. *N. moliniae* (Thümen) Körn., 4. *Tilletia nigrifaciens* Langdon & Boughton, 5. *Ustilago grandis* Fr., 6. *U. mirabilis* Sorokin, 7. *U. phragmitis* L. Ling, 8. *U. phragmitis* Hirschh., 9. *U. typhoides* (Wallr.) Berk. & Broome. Some of them (4, 6) are not smut fungi, others (1, 2, 9) are synonyms or invalidly published (8). Recognised are three species: **1**. *Neovossia moliniae* (type on *Molinia caerulea* (L.) Moench, Yugoslavia), **2**. *Ustilago grandis* (type on *Phragmites australis* (Cav.) Trin. ex Steudel, Europe), and **3**. *Ustilago phragmitis* (type on *Phragmites karka* (Retz.) Trin., Borneo). An additional smut fungus was recently collected in Zambia:

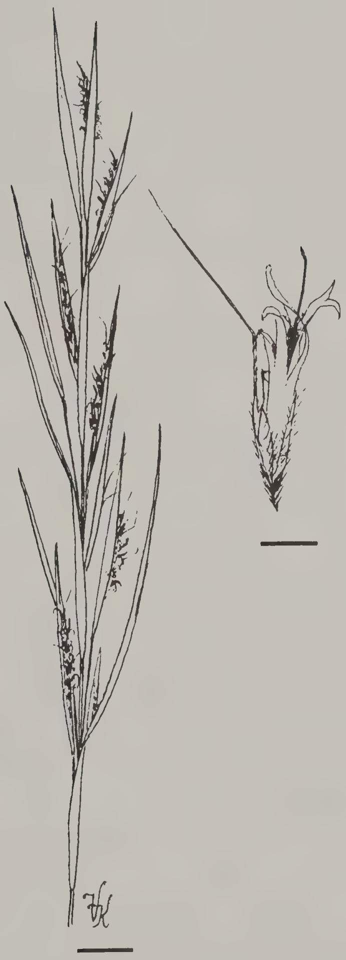

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Fig. 68. Sori of *Sporisorium schizachyrii* Vánky on *Schizachyrium exile* (Hochst.) Pilger (type). Habit and enlarged a spikelet pair with the sorus in the sessile spikelet. Bars = 1 cm for the habit, 3 mm for the detail drawing.

Ustilago mauritiana Vánky, sp. nov.

Typus in matrice *Phragmites mauritianus* Kunth, Zambia, Lusaka Province, 186 km ENE Lusaka, 15°03'37" S, 29°50'06" E, alt. cca. 770 m.s.m., 27.IV.2001, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19641, isotypi in Vánky, Ust. exs. no. 1129. Paratypus: Zambia, Southern Prov., 125 km SE urbe Kafue, 15°55'52" S, 28°22'33" E, alt. cca. 870 m.s.m., 30.IV.2001, leg. C. & K. Vánky, HUV 19642.

Sori in omnibus ovariis eiusdem inflorescentiae, fusiformes, falciformes vel ovoidei, 1–1,5 x 2–4 mm, membrana hispida, primo viridi serius brunnea cooperti, qua maturitate rupta massam atrobrunneam, semiagglutinatam usque pulveream sporarum ostendentes. Fungus deformationem et elongationem organorum floralium internorum producens, ea circum soros sicut taenias longas, irregulares, albidas vel pallide flavas, decrescentes transformans. *Sporae* globosae, subglobosae, plerumque late usque anguste ellipsoidales, (5–)5,5–8 x 5,5–9,5(–11) µm, pallide olivaceobrunneae; pariete aequaliter crasso (cca. 0,5 µm), minute, dense punctato-verruculoso; imago obliqua sporae levis. In statu immaturo evolutionis sori *anamorpha* quaedam praesens sicut pustulae vel integumenta albida ad superficiem involucrorum floralium hypertrophitorum et deformatorum. Conidia matura ovoidea vel naviculiformia, margine rotundata, 6,5–9 x 13–28 µm, hyalina; pariete cca. 0,8 µm crasso, levi.

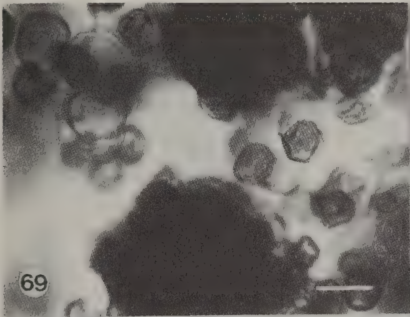
Sori (Fig. 75) in all ovaries of an inflorescence, fusiform, falciform or ovoid, 1–1.5 x 2–4 mm, covered by a pubescent, first green later brown membrane which at maturity ruptures disclosing the dark brown, semiagglutinated to powdery mass of spores. The fungus produces deformation and elongation of inner floral organs which appear as long, irregular, whitish or pale yellow, narrowing bands around the sori. *Spores* (Figs. 73, 74) globose, subglobose, usually broadly to narrowly ellipsoidal, (5–)5.5–8 x 5.5–9.5(–11) µm, pale olivaceous-brown; wall evenly thick (c. 0.5 µm), finely, densely punctate-verruculose; spore profile smooth. At an early stage of sorus development, an *anamorph* is present as white pustules or cover on the surface of the hypertrophied and deformed floral envelopes. Mature conidiospores are ovoid or naviculiform with rounded edges, 6.5–9 x 13–28 µm, hyaline; wall c. 0.8 µm thick, smooth.

On *Phragmites mauritianus* Kunth; C. Africa (Zambia). Known only from the type collections.

Figs. 69, 70. Spores and sterile cells of *Macalpinomyces chloridionis* (L. Ling) Vánky on *Stereochlaena cameronii* (Stapf) Pilger, in LM and in SEM (HUV 19652).

Figs. 71, 72. Spore balls and spores of *Sporisorium schizachyrii* Vánky on *Schizachyrium exile* (Hochst.) Pilger, in LM and in SEM (type).

Figs. 73, 74. Spores of *Ustilago mauritiana* Vánky on *Phragmites mauritianus* Kunth, in LM and in SEM (type). Bars = 10 µm.



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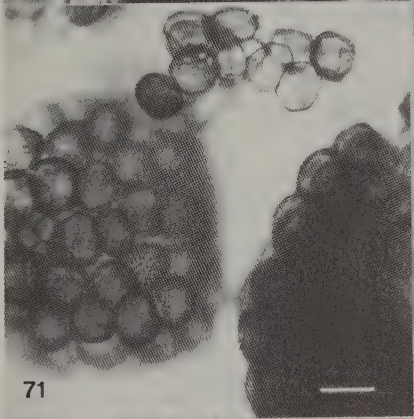

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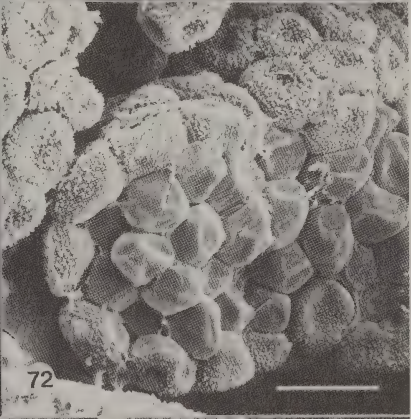

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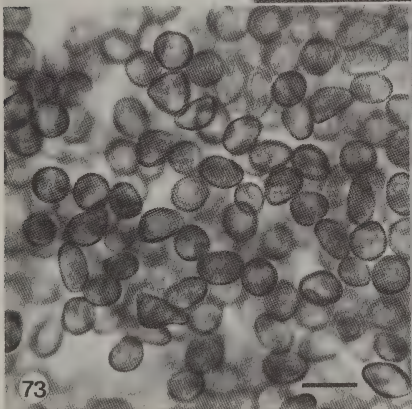

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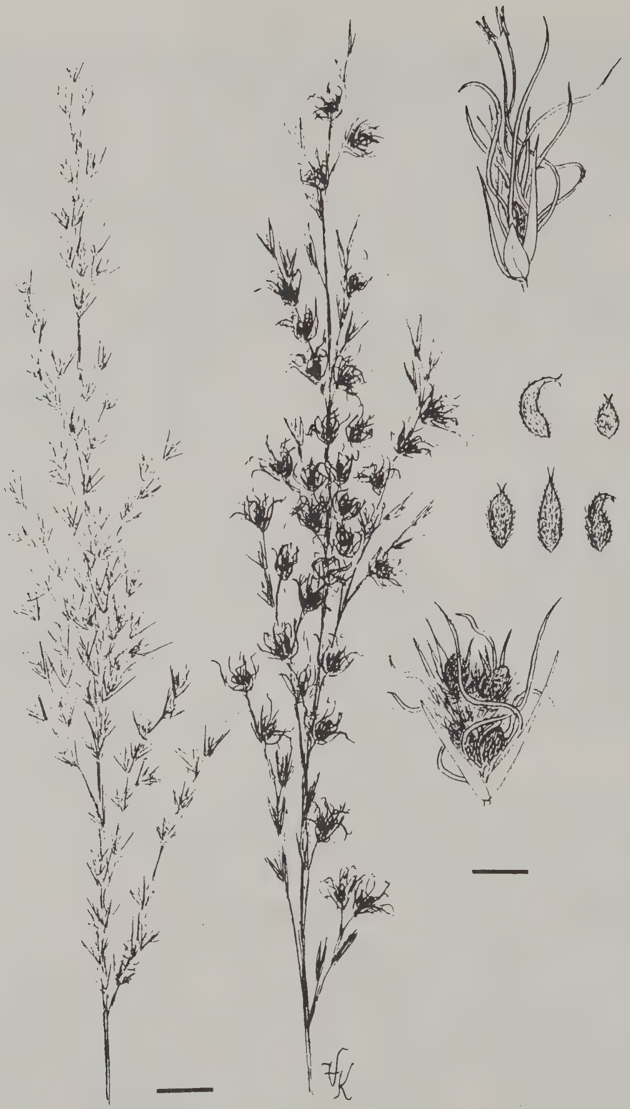

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Fig. 75. Sori of *Ustilago mauritiana* Vánky in the ovaries of *Phragmites mauritianus* Kunth (type). An infected and a healthy inflorescence branch (habit). Enlarged two infected spikelets and some sori.

Bars = 1 cm for the habit, 3 mm for the detail drawings.

Presence of an anamorph of grass-parasitising smut fungi is extremely rare. I only observed an anamorph, preceding the development of the sori of *Ustilago neyraudiae* Mundkur, on *Neyraudia arundinacea* (L.) Henr., a smut fungus rather similar to (but different from) *U. mauritiana*. Based on their parasites, and also on the similarities between *Phragmites* and *Neyraudia* (comp. the comments in Clayton & Renvoize, 1986:204), these two grass genera may be more closely related than it is thought at present, being classified in different subfamilies. (Parasites as host taxonomists!).

Key to the smut fungi of *Phragmites*

1. Sori on the stems .... *Ustilago grandis*
– Sori in the ovaries 2
2. Spores 17–32 µm long, with a long, hyaline appendage ...... *Neovossia moliniae*
– Spores smaller, without appendage 3
3. Spores 7.5–10.5 x 8–14 µm .... *Ustilago phragmitis*
– Spores (5–)5.5–8 x 5.5–9.5(–11) µm .... *Ustilago mauritiana*

THE SMUT FUNGI OF *AXONOPUS* AND *MESOSETUM* (GRAMINEAE)

Axonopus P. Beauv., with about 110 species in tropical and subtropical America, one sp. in Africa, and *Mesosetum* Steud., with 30 species from Mexico to Brazil, belong to the subfam. Panicoideae, tribe Paniceae, subtribe Setariinae (Clayton & Renvoize, 1986:289). On *Axonopus* two, on *Mesosetum* four smut fungi have been published. Of these, *Sphacelotheca inconspicua* has been reported on both of these host genera, hence I am treating the smut fungi of these two genera together. *Ustilago goyazana* Zundel was found to be identical with and a synonym of *Sphacelotheca chaseae* Zundel. The difference between the ovaricolous *Sphacelotheca mesoseti* Zundel and *S. inconspicua* Zundel is minimal and intermediate forms regarding spore measurements, spore wall thickness and sterile cells are present. Therefore, I am treating them as one species. All known smut fungi of *Axonopus* and *Mesosetum* belong to the genus *Sporisorium*. The three recognised species are:

1. *Sporisorium chaseae* (Zundel) Vánky, **comb. nov.**

Basionym: *Sphacelotheca chaseae* Zundel, Mycologia 23:297, 1931. — Type on *Mesosetum ferrugineum* (Trin.) Chase, Brazil, Minas Gerais, Serra do Cipo, 28.III.–1.IV.1925, A. Chase 9135. Lectotype (designated here) BPI 177304, syntype BPI 177303, isolectotype BPI 195084, isosyntype BPI 177305.

Ustilago goyazana Zundel, Mycologia 25:350, 1933. — Type on *Mesosetum loliiforme* (Hochst.) Chase, Brazil, Goyaz, Goyandera, 26.-27.III.1930, A. Chase. Holotype in BPI 160511! Plants of Brazil no. 11555.

Sori destroying the spikelets of which only the distal part of some floral envelopes is left, 4–5 mm long, first covered by a thin greyish peridium which dehisces exposing the semiagglutinated to powdery, dark brown mass of spores surrounding an irregular, central columella with short branches. *Spores* when mature single, subglobose to ellipsoidal, 3.5–5 x 4–6.5 µm, yellowish-brown; wall even, thin, c. 0.5 µm, finely, moderately densely verrucose-echinulate, spore profile smooth to rough. *Sterile cells* globose, ellipsoidal to slightly irregular, about the size of the spores (4–8 µm long), hyaline, single or in irregular groups.

On *Mesosetum ferrugineum* (Trin.) Chase, and *M. loliiforme* (Hochst.) Chase; S. America (Brazil).

2. ***Sporisorium mesoseti*** (Zundel) Vánky, **comb. nov.**

Basionym: *Sphacelotheca mesoseti* Zundel, Mycologia 23:298, 1931. — Type on *Mesosetum loliiforme* (Hochst.) Chase, Brazil, Bahia, Parafuso, 22.XII.1924, A. Chase. Holotype BPI 195070, isotype BPI 178072.

Sphacelotheca inconspicua Zundel, 1933:354. — *Sporisorium inconspicuum* (Zundel) Vánky, 1991:164. — Type on *Mesosetum loliiforme* (Hochst.) Chase, Brazil, Goyaz, near Goyaz City, 20-22.III.1930, A. Chase 11464. Lectotype (designated by Vánky, 1994:164) BPI 177903! Plants of Brazil no. 11464, isolectotypes in BPI 177902 & 195068. Syntype on *Axonopus marginatus* (Trin.) Chase, Brazil, Goyaz, Rio Verde, 2.IV.1930, A. Chase, BPI 177906! Plants of Brazil no. 11710.

Sori in the ovaries, infecting all in the inflorescence, ovoid, 0.5–1 x 2–3 mm, partly hidden by the floral envelopes, first covered by a pale brown peridium which ruptures irregularly disclosing the dark brown, powdery mass of spores surrounding a stout, simple, tapering columella. *Spores* in loose balls, when mature single, rather variable in shape and size, globose, ellipsoidal, usually slightly subpolyhedrally irregular, 6.5–9(–10.5) x 6.5–11(–13) µm, yellowish-brown; wall even or slightly uneven, 0.5(–1) µm thick, finely, densely punctate-verruculose or verrucose-echinulate; spore profile smooth to very finely serrulate. *Sterile cells* in some collections not seen, in others variable, 4–12 x 5.5–14 µm, hyaline, wall thin, c. 0.5 µm .

On *Axonopus marginatus* (Trin.) Chase, *Mesosetum loliiforme* (Hochst.) Chase, and *M. wrightii* Hitchc.; S. America (Brazil) and Great Antilles (Cuba).

Zundel (1931:298) gives "10–14 µ diam." for both measurements of the sterile cells and those of the spores of *Sphacelotheca mesoseti*. The second one is probably an error.

3. ***Sporisorium paranaense*** (Hirschh.) Vánky, **comb. nov.**

Basionym: *Sorosporium paranaense* Hirschhorn, Revista Mus. La Plata, N. S., Sect. Bot. 3:345, 1941 (as "*paranensis*") — *Sphacelotheca paranaensis* (Hirschh.) Hirschhorn, 1986:429. — Type on *Axonopus compressus* (Swartz) P. Beauv., Argentina, Entre Rios, Paraná, Parque Urquiza, X.1938, J. Hirschhorn, isotype in LPS 3641!

Sori comprising the racemes or the whole inflorescence, long cylindrical, 1–2 x 10–25 mm, or sori restricted to the spikelets, ovoid, 0.5–1 x 1–2 mm, first covered by a thick, brown peridium which ruptures irregularly disclosing the dark brown, semiagglutinated to powdery mass of loose spore balls, spores and sterile cells, surrounding a central columella of the length of the sorus. *Spore balls* 30–80 µm long, reddish-brown, composed of numerous spores which separate easily. *Spores* subglobose, ovoid, ellipsoidal to usually slightly irregular, 5.5–8 x 6.5–10(–13) µm, yellowish-brown; wall evenly thick (c. 0.5 µm), finely, densely verruculose-echinulate, spore profile smooth. *Sterile cells* much larger than the spores, 12–18 µm long, in small, irregular groups, hyaline, collapsed in old specimens; wall 1–1.5 µm thick, smooth.

On Gramineae: *Axonopus compressus* (Swartz) P. Beauv.; S. America (Argentina, Uruguay).

Key to the smut fungi (*Sporisorium*) of *Axonopus* and *Mesosetum*

1. Spores 4–6.5 µm long .... *S. chaseae*
– Spores larger 2
2. Sori in the ovaries, 2–4 mm long. Spores 6.5–12 µm long.
   Sterile cells 5.5–13 µm long .... *S. mesoseti*
– Sori usually destroying the whole inflorescence, 10–25 mm long.
   Spores 6.5–9.5 µm long. Sterile cells 12–18 µm long. .... *S. paranaense*

NEW COMBINATIONS

SEVERAL SMUTS REPRESENT THE SAME SPECIES OF *USTANCIOSPORIUM*

The genus *Ustanciosporium* Vánky (1999a:31) was described to accommodate smut fungi forming spore balls in the flowers of Cyperaceae. Based also on molecular data, Piepenbring (2000:330) widened its delimitation, including also related smut fungi possessing single spores.

Several smut fungi, recently collected in Zimbabwe on *Bulbostylis* and *Cyperus*, as well as the type of *Thecaphora africana* on *Rikliella kernii*, and that of *Sorosporium apparaoi* on *Kyllinga triceps*, turned out to represent the same fungus, known as *Sorosporium kuwanoanum*. It belongs to the genus *Ustanciosporium* as:

Ustanciosporium kuwanoanum (Togashi & Y. Maki) Vánky, **comb. nov.** Basionym: *Sorosporium kuwanoanaum* Togashi & Y. Maki, Ann. Phytopathol. Soc. Japan 10:139, 1940. — Type on *Bulbostylis barbata* Kunth, Japan, Prov. Chikuzen, Fukuoka, 5.X.1938, leg. K. Kuwano, isotype in HUV 11716!

Thecaphora africana H. Scholz, 1981:106. — Type on *Rikliella kernii* (Raym.) J. Rayn., Togo, Circ. Dapaon (Dapango), N of Timbou, 12.X.1977, H. Ern, B. Leunberger, H. & U. Scholz and W. Schwarz, B!

Sorosporium apparaoi G. K. Rao, 1982:84. — Type on *Kyllinga triceps* Rottb. (nom. illeg.; = *Cyperus triceps* Endl.), India, Andhra Pradesh, Hyderabad, Agricultural College Campus, 9.X.1969, G. K. Rao, IMI 143450, isotype in HUV 17970!

Sori on the surface of inner floral organs, hidden by the floral envelopes, forming a black, first agglutinated, later granular-powdery mass of spore balls and spores, 0.3–1.2 mm in diameter. *Spore balls* variable in shape and size, irregular, often elongated, 20–70 µm long, dark reddish-brown, composed of 2–20 (or more), easily separating spores. *Spores* extremely variable in shape and also in size, (8–)9–13.5 x (9–)11–20(–22) µm, yellowish- to reddish-brown; wall unevenly thick, 0.5–3 µm, thickest at the angles, surface irregularly, minutely foveolate-verruculose.

On Cyperaceae: *Bulbostylis barbata* Kunth, *B. densa* (Wall.) Hand.-Mazz., (*Abildgaardia densa* (Wall.) K. Lye), *B. hispidula* (Vahl) R. Haines (*Fimbristylis hispidula* (Vahl) Kunth), *Cyperus amabilis* Vahl, *Cyperus triceps* Endl. (*Kyllinga triceps* Rottb., nom. illeg.), *Rikliella kernii* (Raym.) J. Rayn. (*Scirpus kernii* Raym.); E. Asia (China, Japan), Africa (Togo, Zimbabwe).

The size of the spores of the type specimen of *Sorosporium apparaoi* is slightly smaller in average than other collections seen by me. Other morphological characters fit well with those of the type species. Differences in the darkness of the colour of the spores, seen in different collections (and also within the same collection), are also considered to be variations within the same species.

Suddia Renvoize is a unispecific grass genus in the subfam. Bambusoideae, tribe Phareae. *Suddia sagittifolia* Renvoize, a marsh grass, was collected in Sudan. "The only panicles collected have been damaged by a smut fungus" (Clayton & Renvoize, 1986:68). The smut fungus was described as *Sphacelotheca suddiana* Spooner (1984:463). However, *Sphacelotheca* is restricted to dicotyledonous host plants in the Polygonaceae. The graminicolous "*Sphacelotheca*" species mostly belong to the genus *Sporisorium* Ehrenberg ex Link (comp. Vánky, 1987:104). A study of the type specimen of *Sphacelotheca suddiana*, kindly sent by Dr. B. M. Spooner, showed that the fungus is best placed in the genus *Ustilago*.

Ustilago suddiana (Spooner) Vánky, **comb. nov.**

Basionym: *Sphacelotheca suddiana* Spooner, Kew Bull. 39:463, 1984. — Type on *Suddia sagittifolia* Renvoize, Sudan, Jonglei, 1982, J. M. Lock 82/21. Holotype in K, isotype in HUV 12097.

Sori in the ovaries, ovoid, c. 1 mm long, completely hidden by the floral envelopes, first covered by the thin pericarp which ruptures disclosing the beige-brown, powdery mass of spores. Infection systemic; all ovaries of an inflorescence are infected. *Spores* globose, subglobose, ovoid to broadly ellipsoidal, variable in size, (6.5–)7–9.5 x 7–11 µm, pale yellowish-brown; wall evenly thick, c. 0.5 µm, finely, densely punctate-verruculose, spore profile smooth. In SEM spore surface finely verrucose-echinulate.

On Gramineae: *Suddia sagittifolia* Renvoize; Sudan. Known only from the type collection.

The systematic position of *Ustilago bursa* was for a long time uncertain. Its main characters are: *Sori* in some ovaries of an inflorescence, swollen, covered by a thick, first green, later brown membrane of the pericarp and fungal elements, filled by a spore mass which separates into irregular groups of spores or into single spores, intermixed with small to large groups of globoid, thin-walled, hyaline sterile cells. These characters fit with those of the emended *Macalpinomyces* Langdon & Fullerton (see Vánky, 1996b:119; 1997a:129), hence the new combination proposed:

Macalpinomyces bursus (Berk.) Vánky, **comb. nov.**

Basionym: *Ustilago bursa* Berkeley, in Hooker's J. Bot. Kew Gard. Misc. 6:206, 1854. — *Tolyposporium bursum* (Berk.) McAlpine, 1910:186. — *Sphacelotheca bursa* (Berk.) Mundkur & Thirumalachar, 1946:6. — *Sporisorium bursum* (Berk.) Vánky, 1988:403. — Type on *Anthistiria arundinacea* Roxb. (= *Themeda arundinacea* (Roxb.) Ridley, India, Sikkim, 1879, Dr. Hooker, Herb. Berkeley no. 4733, K!

On Gramineae: *Themeda arundinacea* (Roxb.) Ridley, and *T. quadrivalvis* (L.) O. Kuntze; S. Asia (India).

For detailed description see Vánky, 1994b:164 (as *Ustilago bursa*).

Having studied several new collections of "*Sporisorium*" *ovariicolopsis* Vánky, in its different developmental stages, it turned out that it should be transferred into the genus *Macalpinomyces* as:

Macalpinomyces ovariicolopsis (Vánky) Vánky, **comb. nov.**

Basionym: *Sporisorium ovariicolopsis* Vánky, Mycotaxon 74:203, 2000a. — Type on *Andropogon gayanus* Kunth, Zimbabwe, Matabeleland North Prov., 12 km N of Lusulu, 16.III.1999, coll. C. & K. Vánky. Holotype in HUV 18903, isotypes in BPI 746891 and in IMI 380467.

On Gramineae: *Andropogon gayanus* Kunth; C. & S. Africa (Malawi, Zambia, Zimbabwe).

For description and illustrations see Vánky, 2000a:203-205 (as *Sporisorium ovariicolopsis*).

Walker (2001:225) described a new genus, ***Yelsemia*** J. Walker, with the type *Y. arthropodii* J. Walker on *Arthropodium minus* R. Br. (Liliaceae s. lat.) in Australia. Walker (2001:231) also showed that the spores of *Ustilago speculariae* J. A. Stev. (type on *Specularia perfoliata* (L.) DC., Campanulaceae, USA), are strikingly similar to those of *Y. arthropodii*. The former is on an advanced dicotyledonous family, the latter on a relatively advanced monocotyledon, widely separated geographically. Unfortunately, the spore germination of *Ustilago* *speculariae* is not known. Without knowing the spore germination, and because of the taxonomy of the host plants and the geographic isolation, Walker hesitated to recombine *U. speculariae* into the genus *Yelsemia*. The knowledge of the ultrastructure of these two smuts helps in their classification. In both species, the host-parasite interaction is realised by haustoria and the septal pore is simple with membrane caps, inner plates are lacking (R. Bauer, pers. comm.), denoting that they belong to the same genus, *Yelsemia*. Consequently, the following new combination is proposed:

Yelsemia speculariae (J. A. Stev.) Vánky & R. Bauer, **comb. nov.**
Basionym: *Ustilago speculariae* J. A. Stevenson, Mycologia 38:525, 1946. — Type on *Specularia perfoliata* (L.) DC. (= *Triodanis perfoliata* (L.) Nieuwl.), USA, Oklahoma, Pittsburg Co., McAlester, 27.V.1920, F. W. Pennell 10592. Isotypes in BPI 166548! and NY 13980.

Sori in the capsules of the host plants, which rupture irregularly disclosing the black, powdery mass of spores. *Spores* globose to subglobose, rarely ellipsoidal, 21–27 µm in diameter, dark reddish-brown, with two, opposite, pale brown polar caps which in facial view appear as paler, circular areas of 12–16(–18) µm diameter; wall c. 2 µm thick in the dark, equatorial area, thinner over the polar areas. In SEM, the spore surface is finely, densely verruculose, including the polar caps, where the dried spores are impressed.

On Campanulaceae: *Triodanis perfoliata* (L.) Nieuwl. (*Specularia perfoliata* (L.) DC.); North America (USA), very rarely collected.

In the new classificatory system (comp. Bauer et al., 1997, 2001, Begerow et al., 1997/1998, Vánky, 1999b), *Yelsemia* was placed (Vánky, in press) into the Melanotaeniaceae Begerow, R. Bauer & Oberw. family, within the order Urocystales R. Bauer & Oberw. of the subclass Ustilaginomycetidae Jülich, emend R. Bauer & Oberw., class Ustilaginomycetes R. Bauer, Oberw. & Vánky.

Knowing the close relationship of the genera *Yelsemia* and *Urocystis* Rabenh. ex Fuckel, the unrelated host plants of the two *Yelsemia* species is no longer curious. *Urocystis*, a natural, well-delimited genus, with c. 140 known species, is parasitising 21 host plant families, both mono- (6) and dicotyledonous (15) ones.

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MYCOTAXON

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TWO NEW SPECIES OF UROCYSTIS AND A UROCYSTIS (USTILAGINOMYCETES) NEW TO CHINA

LIN GUO
Systematic Mycology & Lichenology Laboratory
Institute of Microbiology, Chinese Academy of Sciences, Beijing 100080, China

ABSTRACT Two new species of *Urocystis* are described and a new species record of *Urocystis* is given from China.

KEY WORDS Smut fungi, *Urocystis achnatheri*, *Urocystis helanensis*, *Urocystis irregularis*

Vánky (1991) listed four species of *Urocystis* forming on *Stipa* throughout the world, i.e., *U. fraserii* G. P. Clinton, *U. granulosa* G. P. Clinton, *U. stipae* McAlpine and *U. corsica* (Mayor & Terrier) Vánky. On *Achnatherum* and *Stipa* two species, *U. granulosa* and *U. stipae* have been reported from China (Wang 1963, Vánky 1991). Some smut specimens on *Achnatherum* were kept as *U. stipae* in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (HMAS). Only one specimen (HMAS 31441) belongs to *U. stipae*. The others differ from *U. stipae* in having more ustilospores per spore ball. These specimens are described as the following new species:

Urocystis achnatheri L. Guo, **sp. nov**. Fig. 1

Sori in foliis et vaginis, primo epidermide obtectas, deinde rupturas. Massa sporarum nigrobrunnea, pulverulenta. Glomeruli sporarum subglobosi, elliptici, ovoidei vel elongati, e ustilosporis 1-10 constructi, cellulis sterilibus omnino circumdati, 15-55 × 14-40 μm. Ustilosporae subglobosae, ovoideae vel ellipticae, 9.5-17.5 × 8-15 μm, flavidobrunneae vel rufobrunneae. Cellulae steriles subglobosae vel ellipticae, 7.5-15 × 5-9 μm, flavidobrunneae; pariete 1-2 μm crasso, levi.

Sori in leaves and sheaths, at first covered by the epidermis, later ruptured. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or elongated, 15-55 × 14-40 μm, composed of 1-10 ustilospores, completely surrounded by sterile cells. Ustilospores subglobose, ovoid or ellipsoidal, 9.5-17.5 × 8-15 μm, yellowish-brown or reddish-brown. Sterile cells subglobose or ellipsoidal, 7.5-15 ×

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5-9 μm, yellowish-brown; wall 1-2 μm, smooth.

On *Achnatherum sibiricum* (L.) Keng, Qinghai: Minhe, 20 IX 1959, J. C. Xing & Q. M. Ma 1821, HMAS 31442 (holotypus); Nei Mongol: Xilinhot, 23 VIII 1963, J. G. Luo, HMAS 34347.

Urocystis stipae McAlpine,
The Smuts of Australia. p. 198, 1910. Fig. 2

Sori in leaves, sheaths and stems, at first covered by the epidermis, which later ruptures. Spore mass black, powdery. Spore balls subglobose, ellipsoidal, ovoid or elongated, 18-39 × 17-33 μm, composed of 1-5(-6) ustilospores, completely surrounded by sterile cells. Ustilospores globose, subglobose, ovoid or ellipsoidal, 13.5-18 × 10.5-15 μm, yellowish-brown or reddish-brown. Sterile cells subglobose or ellipsoidal, 6-9.5 × 4.5-7 μm, yellowish-brown; wall smooth.

On *Achnatherum splendens* (Trin.) Nevski, Qinghai: Wulan, 31 VII 1959, J. C. Xing & Q. M. Ma 1284, HMAS 31441.

Urocystis stipae differs from *U. achnatheri* in having fewer ustilospores per spore ball. The former species was wrongly described by Wang (1963) as having spore balls composed of 2-8 ustilospores.

On the genera *Achnatherum* and *Stipa*, three species of *Urocystis* are recognized from China. These are: *U. achnatheri*, *U. stipae* and *U. granulosa*.

Key to *Urocystis* on the genera *Achnatherum* and *Stipa* in China

1. Sori in the spikelets. Ustilospores per spore ball 1-10, on *Stipa*.........*U. granulosa*
1. Sori in the leaves, on *Achnatherum*..2
2. Ustilospores per spore ball 1-5(-6)..*U. stipae*
2. Ustilospores per spore ball 1-10...*U. achnatheri*

Urocystis helanensis L. Guo, **sp. nov**. Fig. 3

Sori in rhizomatibus, epidermide obtectas. Massa sporarum atra, pulverulenta. Glomeruli sporarum globosi, subglobosi, elliptici, ovoidei vel irregulares, e ustilosporis 1-4 (6 vel 7) constructi, cellulis sterilibus omnino circumdati, 16-38(-49) × 13-28.5 μm. Ustilosporae subglobosae, ovoideae, ellipticae vel irregulares, 12.5-20 × 10-15 μm, rufobrunneae vel nigrobrunneae. Cellulae steriles subglobosae vel ellipticae, 5-12 × 5-9 μm, flavidobrunneae; pariete 1-2 μm crasso, levi.

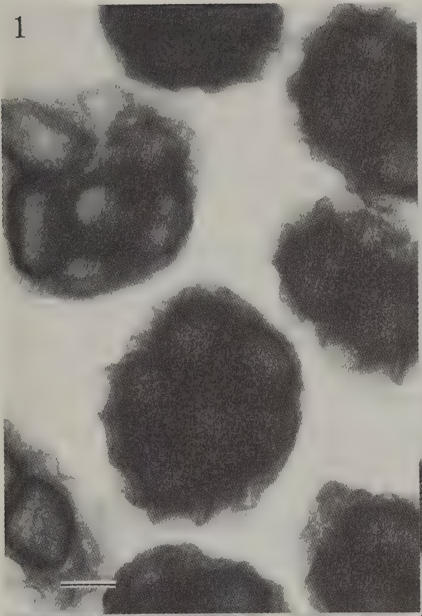
Fig. 1. Spore balls and ustilospores of *Urocystis achnatheri* on *Achnatherum sibiricum* in LM (HMAS 31442, holotypus).

Fig. 2. Spore balls and ustilospores of *Urocystis stipae* on *Achnatherum splendens* in LM (HMAS 31441).

Fig. 3. Spore balls and ustilospores of *Urocystis helanensis* on *Polygonatum verticillatum* in LM (HMAS 62200, holotypus).

Fig. 4. Spore balls and ustilospores of *Urocystis irregularis* on *Aconitum barbatum* in LM (HMAS 80700). Bars = 11 μm

1



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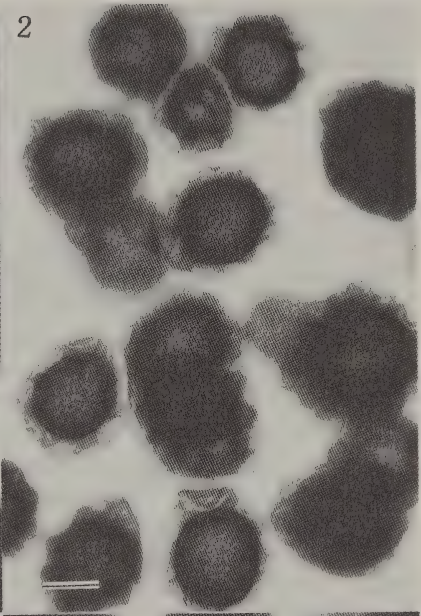

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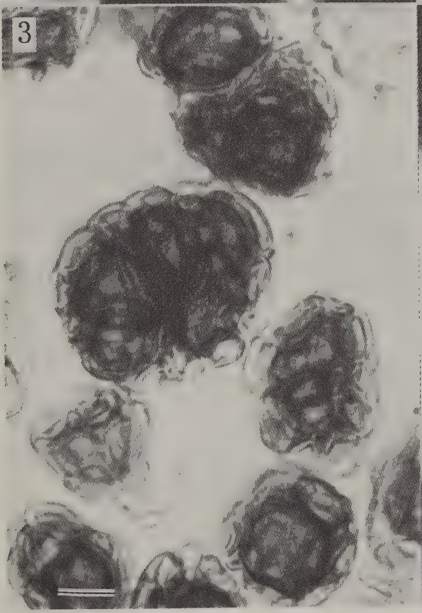

4

Sori in rhizomes, covered by the epidermis. Spore mass black, powdery. Spore balls globose, subglobose, ellipsoidal, ovoid or irregular, 16-38(-49)×13-28.5 µm, composed of 1-4 (6 or 7) ustilospores, completely surrounded by sterile cells. Ustilospores subglobose, ovoid, ellipsoidal or slightly irregular, 12.5-20×10-15 µm, reddish-brown or blackish-brown. Sterile cells subglobose or ellipsoidal, 5-12×5-9 µm, yellowish-brown; wall 1-2 µm, smooth.

On *Polygonatum verticillatum* (L.) All., Ningxia: Helan Shan, 4 VI 1961, S. J. Han, Q. M. Ma, Q. Z. Wang, & R. Liu 2066, HMAS 62200 (holotypus), HMAS 31578 (isotypus).

The specimen HMAS 31578 was wrongly identified as *Urocystis colchici* (Schltdl.) Rabenh. (Wang 1963). *Urocystis colchici* differs from *U. helanensis* in possessing fewer ustilospores [1-3(-4)] per ball. The specimen HMAS 62200 was wrongly identified as *U. miyabeana* Togashi & Onuma (Guo 1992). *Urocystis helanensis* is similar to *U. miyabeana* from which it differs in having more ustilospores per ball. The latter has 1-3(-4) ustilospores per ball.

Urocystis irregularis (G. Winter) Săvul.,

Bul. Şti. Acad. Republ. Populare Române 3:220, 1951. Fig. 4

Sori in leaves, petioles and stems, causing swellings, covered by the epidermis. Spore mass blackish-brown, semi-agglutinated. Spore balls subglobose, elongated or irregular, 20-55(-59) × 15-34 µm, composed of 1-7 ustilospores, incompletely surrounded by sterile cells. Ustilospores subglobose, ovoid, irregular or slightly polyhedral, 15-23×9-15 µm, reddish-brown or dark brown. Sterile cells ellipsoidal, 7.5-15×5-10 µm, yellowish-brown.

On *Aconitum barbatum* Pers., Beijing: Baihua Shan, 17 VI 1964, X. J. Liu & Y. C. Zong 30, HMAS 80700.

Urocystis irregularis is a new species record for China (Ling 1953, Wang 1963, Tai 1979) on a new host plant, *Aconitum barbatum*.

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PUCCINIA ARIORUM SP. NOV. AND OTHER NOTEWORTHY GRAMINICOLOUS RUST FUNGI (UREDINALES) FROM IRAN

M. Abbasi[1], Gh.A. Hedjaroude[2], H.B. Gjaerum[3] and
M. Scholler[4]

[1]Plant Pests and Diseases Research Institute, Tehran, Iran,
[2]College of Agriculture,Tehran University, Karaj, Iran,
[3]Norwegian Crop Research Institute, Plant Protection Centre, Norway and
[4]Arthur and Kriebel Herbaria, Department of Botany and Plant Pathology,
Purdue,University, West Lafayette, IN, USA

SUMMARY

This article lists one new *Puccinia* species and six otherwise noteworthy Iranian rust fungi (Uredinales) on Poaceae. New to science is *Puccinia ariorum* sp. nov., a species with verrucose teliospores on *Bromus danthoniae*. *Puccinia australis* on *Cleistogenes serotina*, *P. fragosoana* on *Imperata cylindrica*, *Uromyces ferganensis* on *Stipa caucasica* and *S. holosericea,* and *U. setariae-italicae* on *Panicum* sp. and *Setaria glauca* are reported for the first time for Iran. *Puccinia stipae* var. *stipina* was found for the first time on a telial host (*S. pennata* subsp. *zalesskii* and *S. holosericea*) in Iran. Finally, a very rare species, *P. schoenanthi*, was found on *Cymbopogon olivieri* in southern Iran. All specimens are described in detail and some are documented with microphotographs.

INTRODUCTION

Forty-five rust fungus species on Poaceae belonging to two genera are known from Iran (Ershad 1995, Abbasi *et al*., 1996). In the following we provide detailed descriptions of six additional and one very rare species. One species is also new to science.

MATERIAL AND METHODS

Spores from dried specimens were mounted in lactophenol and examined with an Olympus BH2 Nomarski Differential Interference Contrast Microscope (DIC) at a magnification of x 400 or x 1000. Fifty spores per specimen were randomly selected and measured. Specimens are deposited in the Herbarium Ministerii Iranici Agriculturae (IRAN) in Tehran and duplicates in the Arthur and Kriebel Herbaria, Purdue University (PUR). Spore state and life cycle terminology follows Cummins & Hiratsuka (1983).

DESCRIPTION OF SPECIES

Puccinia ariorum M. Abbasi, Hedjar., Gjaerum & M. Scholler, **sp. nov**.
II, III on *Bromus danthoniae* Trin. var. *danthoniae*, Chahar Mahal-e Bakhtiari, 2 km W of Babaheidar, alt. 2200 m, 14 May 1994, leg. M. Abbasi and R. Fritsch (IRAN 10643 F).

Diagnosis latina
Spermogonia et aecia ignota. Uredinia amphigena, cinnamomeo-brunnea, plerumque teliis circumdata; urediniosporae 23-30 x 19-23 µm, ellipsoideae vel obovoidae, paries 1.5-2 µm crassus, luteolo-brunneus, echinulatus, pori germinationis 7-9, sparsi. Telia amphigena, sparsa vel irregulariter aggregata, oblonga, diu epidermide coperta, atro-brunnea, paraphyses absentes; teliosporae (34-)36-50(-54) x (16-)18-23(-26) µm, ellipsoideae, clavatae vel oblongae, paries lateralis 1-1.5 µm crassus, apicalis ad 3 µm, rugosus vel punctato-verrucosus, castaneus, basim versus pallidior, pori germinationis obscuri in ambabus cellulis; sporae 1-cellulares frequentes, sed numero variabili, nonnumquam 3-cellulares; pedicelli hyalini, breves et fragiles. Holotypus in IRAN (10643 F), isotypus PUR (N1739).

Spermogonia and aecia unknown. Uredinia amphigenous, cinnamon-brown, mostly surrounded by telia; urediniospores 23-30 x 19-23 µm, ellipsoid or obovoid, wall 1.5-2 µm thick, yellowish brown, echinulate, germ pores 7-9, scattered. Telia amphigenous, scattered or irregularly aggregated, oblong, long covered by the epidermis, blackish brown, paraphyses missing; teliospores (34-)36-50(-54) x (16-)18-23(-26) µm, ellipsoid, clavate or oblong, wall 1-1.5 µm thick at the sides and up to 3 µm apically, rugose or punctate-verrucose, chestnut-brown, paler below, germ pores obscure in both cells; 1-celled spores common, but variable in number, 3-celled spores occasional; pedicels colorless, short and fragile (Fig. 1).
Etymology: This species is named after the Arians, a people who have lived in Iran since prehistoric time.

Cummins (1971) lists five additional *Puccinia* species on Poaceae with ornamented teliospore walls. Based on features of the telia only, the six species can be delimited as follows:

1 Teliospores striated with continuous or interrupted ridges; on *Agropyron* and *Elymus*...*P. pattersoniana* Arthur
1* Teliospores verrucose, but not striated...2

2 Teliospores on average wider than 40 µm, wall at the sides 8-10 µm thick; on *Stipa*... *P. wolgensis* Navashin
2* Teliospores on average narrower than 35 µm, wall at the sides less than 6 µm thick..3

3 Telia long covered by epidermis; one-celled teliospores common; two-celled teliospores on average 43 x 20 µm, on *Bromus*.................*P. ariorum*
3* Telia soon erumpent; one-celled teliospores rare or missing; on *Avenochloa, Melica* 4

4 Telia on *Melica*..*P. paradoxica* Ricker
4* Telia on *Avenochloa* 5

5 Teliospores on average about 50 x 31.5 µm.............*P. pratensis* A. Blytt
5* Teliospores smaller, on average about 42.5 x 29 µm...*P. bromoides* Guyot

Cummins (1971: 299) pointed out that features of *P. pratensis* and *P. bromoides* overlap.

Puccinia australis Körn.
In: Thümen, Fungi Austriaci No. 842. 1873.
0, I on *Sedum hispanicum* L., Golestan Prov., Golestan National Park, Tang-e Gol, alt. 650 m, 19 May 1992, M. Abbasi and J. Fatehi (IRAN 10505 F, PUR N1740).
II, III on *Cleistogenes serotina* (Lk.) Keng, Golestan National Park, Tang-e Gol, alt. 650 m, 16 July 1991, M. Abbasi (IRAN 8733 F, PUR N1741).

Spermogonia amphigenous, in clusters, sometimes surrounded by aecia, honey-colored. Aecia amphigenous on leaves and on stems, in groups, cylindrical, elongated, up to 0.7 mm long, peridium white; aeciospores 16-21 x 14-17 µm, angular, ellipsoid or mostly globoid, wall finely verrucose, 1-1.5 µm thick, hyaline. Uredinia mostly on the abaxial surface, nearly colorless, scattered, small, oblong, pulverulent; urediniospores broadly obovoid, broadly ellipsoid or subglobose, 20-25(-27) x 17-21 µm, wall pale yellowish or hyaline, mostly 2 µm thick, echinulate, with 6-8 scattered rather indistinct pores. Telia mostly on abaxial surface, early exposed, blackish, scattered, oblong; teliospores 26-42 x 18-26 µm, broadly obovoid, obovoid, ellipsoid or broadly ellipsoid, wall smooth, 5-7(-8) µm thick at the apex, 2-4 µm thick at the sides, chestnut-brown or deep golden-brown, sometimes becoming paler downwards, the apex often with a paler outer area; pedicel hyaline, persistent, up to 70 µm long (Fig. 2). Infected aecial and telial host were found in the direct neighborhood.

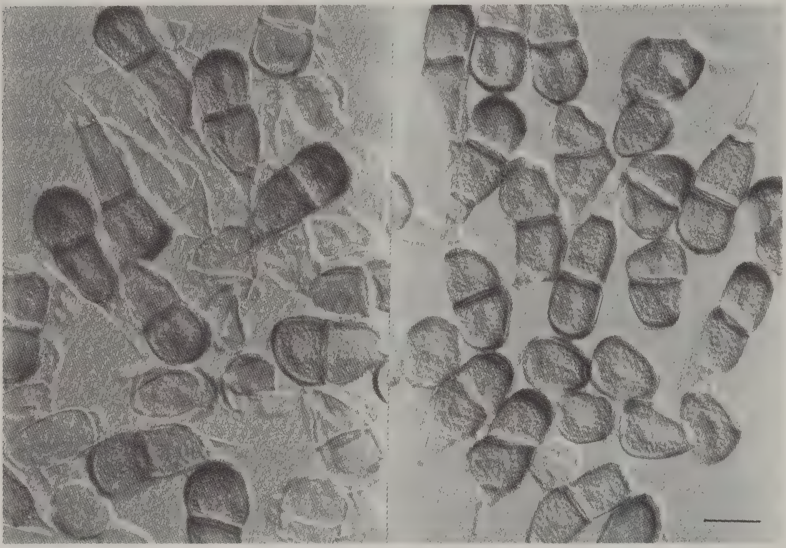

Fig. 1. *Puccinia ariorum* M. Abbasi, Hedjar., Gjaerum & M. Scholler, teliospores and mesospores (type). Bar = 20 µm.

Cummins (1971) listed two additional species of *Puccinia* on *Cleistogenes.* The first species, *P. diplachnicola* Diet., has narrower teliospores and clearly smaller urediniospores. The second, *P. permixta* P. Syd. & Syd., has larger teliospores and darker urediniospore walls. The Iranian material fits well with the holotype (PUR F16358). Guyot & Massenot (1958) pointed out that the teliospores of this species around the apical pores are "subverruculeux". This feature is confirmed by the material studied. *Puccinia australis* is recorded for the first time for Iran.

Puccinia fragosoana Beltrán
Mem. R. Soc. Esp. Hist. Nat. 50: 242, 1921.
II, III on *Imperata cylindrica* (L.) Raeusch.

Mazandaran, Sari, 20 May 1978, N. Ale-Agha (IRAN 11371 F, PUR N1742); Gilan, Rodsar, Sep. 2000, M. A. Tajik-Ghanbari (IRAN 11369 F, PUR N1743); Rasht, Ziba-Kenar, 31 Aug. 1993, M. Abbasi (IRAN 11370 F, PUR N1744) (only II).

Uredinia amphigenous, linear, scattered or arrenged in rows, sometimes confluent, up to 5 mm long, dark brown, with capitate, brownish paraphyses, often strongly thickened at the apex (up to 13 µm); urediniospores (27-)30-40 (-44) x 19-27 µm, obovoid or oblong-obovoid, wall 1.5-2 µm thick at the sides, up to 6 µm (10 µm in specimen no. 11371) at the apex, cinnamon- to chestnut-brown, echinulate and with 3-4 (-6) equatorial pores. Telia oblong, seriate, erumpent; teliospores mostly ellipsoid, rounded at both ends or slightly narrowed basally, 26-42 x 17-24(-28) µm, wall chestnut-brown, smooth; pedicel brownish, up to 35 µm (IRAN 11369) and 90 µm long (IRAN 11371), respectively. Pedicel length of the teliospores and thickness of the apical urediniospore wall are variable. In IRAN 11371, e.g., the pedicel is twice as long as described by Beltrán (1921) (type not seen). Eboh & Obike (1977) reported a specimen with long pedicels from Nigeria as well. Further material studied from Palestine (PUR F10830) and Africa (PUR F14972, PUR 11292) confirmed this observation. PUR specimens were especially variable in thickness of the apical urediniospore wall. *Puccinia rufipes* Dietel, which occurs on the same host, has no thickened urediniospore walls. *Puccinia fragosoana* is reported for the first time from Iran.

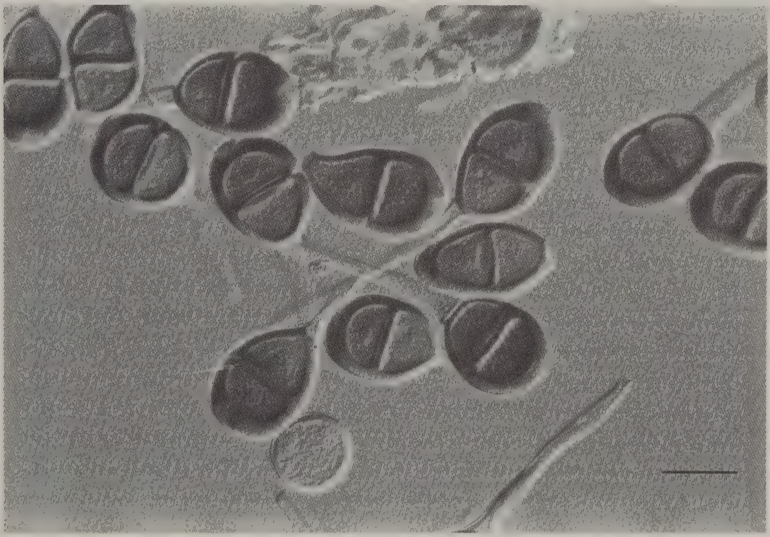

Fig. 2. *Puccinia australis* Körn., teliospores and urediniospore. Bar = 20 µm.

Puccinia stipae Arthur var. **stipina** (Tranzschel ex Kleb.) H. C. Greene & Cummins

Mycologia 50: 21, 1958.

II, III on *Stipa pennata* L. subsp. *zalesskii* (Wilensky) Freitag (IRAN 10996 F, PUR N1745), on *S. holosericea* Trin. (IRAN 10646 F, PUR N1746), Mazandaran, Haraz road, Hareh, alt. *ca* 2100 m, 5 August 1993, M. Abbasi, J. Fatehi and Z. Ghanbari.

Urediniospores in IRAN 10996 are mostly globoid, 20-24(-28) x 16-23 µm, with (5-)6-8(-9) scattered germ pores; teliospores 39-56(-68) x 18-25(-29) µm, pale spores usually longer than darker spores, mostly ellipsoid or oblong-ellipsoid, conically attenuate or rounded above, wall 1.5-2 µm thick at the sides, up to 10 µm thick apically, golden- to chestnut-brown, one-celled and 3-celled spores present (Fig. 3). Material of *P. stipina* Tranzschel ex Kleb. studied from Europe (PUR N433, PUR N431, PUR F17433) corresponds well with IRAN 10996. In IRAN 10646 (on *S. holosericea*), urediniospores are 26-29 x 24-27 µm with 8-9 scattered germ pores, and teliospores are 40-58(-73) x 18-26(-33) µm. IRAN 10646 differs slightly from other specimens studied by having wider, more evenly ellipsoid and more apically rounded teliospores. On the other hand, the specimen clearly differs from the other two varieties accepted by Greene & Cummins (1958). Therefore we placed it in var. *stipina* but the study of further material on

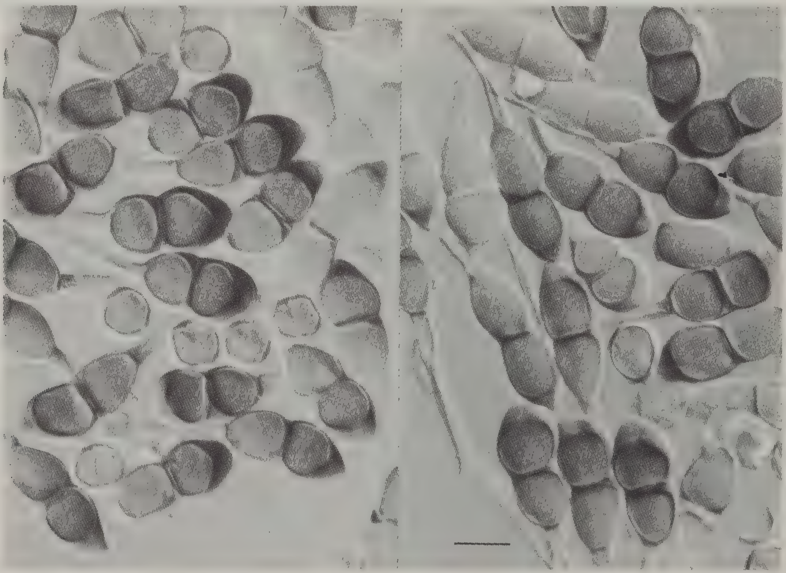

Fig. 3. *Puccinia stipae* Arthur var. *stipina* (Tranzschel ex Kleb.) H. C. Greene & Cummins (IRAN 10996 F), teliospores and urediniospores. Bar = 20 µm.

Stipa holosericea may require the description of an additional variety. These are the first records of *P. stipae* var. *stipina* on the telial host from Iran. On the aecial host, *Eremostachys laciniata* Bunge (Lamiaceae), the fungus was already found earlier (Jørstad 1960, Ershad 1995).

Puccinia schoenanthi Cummins & Guyot
In: Cummins, The rust fungi of cereals, grasses and bamboos, p. 401. 1971.
II, III on *Cymbopogon olivieri* (Boiss.) Bor
Khuzestan, Dezful, Bisheh-Bozan towards Shahion, alt. 600 m, 25 April 1995, Jafarzadeh & Nainii (IRAN 11372 F, PUR N1747).

Uredinia hypophyllous, cinnamon-brown; urediniospores globose or obovoid, 22-26 x 20-24 µm, wall cinnamon-brown, 3-4 µm thick, verruculose, germ pores 2-(3), equatorial or slightly superequatorial; telia hypophyllous, linear or elongated, often seriate and when confluent reaching up to 2 cm length, blackish brown, exposed, compact; teliospores (36-)40-50(-57) x (23-)25-31 µm, ellipsoid, broadly ellipsoid, broadly obovoid or elongate-obovoid, wall up to 12 µm thick apically, chestnut- or clear chestnut-brown, smooth or punctate-rugose; 1-celled spores common; pedicel persistent, thick-walled, colorless, up to 127 µm long (Fig.4). So far, there are only two records of this species, one on *C. schoenanthus* (L.) Spreng. from Iran (type, PUR F16543) and one on *C. olivieri* from Iraq (PUR F17589; see Cummins 1971). We re-studied this material and found that both specimens contain one-celled teliospores as well. This feature is neither mentioned in the protologue nor elsewhere. We agree with Cummins (1971) that Urban's (1966) report of *P. crassapicalis* Bubák on *C. schoenanthus* from Iraq probably refers to this rust species.

Uromyces setariae-italicae Yoshino
Bot. Mag. Tokyo 20: 247. 1906.
II, III on *Setaria glauca* (L.) Beauv., Gorgan, Kordkoy, Oct. and Dec. 1994, M. Montazeri (IRAN 9083F, PUR N1748); Khozestan, Mollassani, date unknown, before 1995, H. Poor-Mahmoodabadi (IRAN 11182 F, PUR N1749); Gilan, Soomeh-Sara, 6 Oct. 1997, A. Khodaparast (IRAN 11183F, PUR N1750).
On *Panicum* sp., Baluchestan, Kahir, 4 Apr. 1996, V. Khossravi (IRAN 9725 F, PUR N1751) (only II).

Uredinia amphigenous on leaves, pulverulent, cinnamon-brown; urediniospores broadly obovoid or ellipsoid, echinulate, cinnamon-brown, 26-37 x 22-28 µm, germ pores 3-4, equatorial. Telia hypophyllous or on sheaths, small and inconspicuous, covered by the epidermis, black or grayish black; teliospores 20-29 x 15-21 µm, angularly globoid or obovoid, thin-walled, yellowish, yellowish brown or clear chestnut-brown; pedicels colorless, fragile, as long as the spores or shorter.

U. setariae-italicae is a new member of the Iranian rust flora.

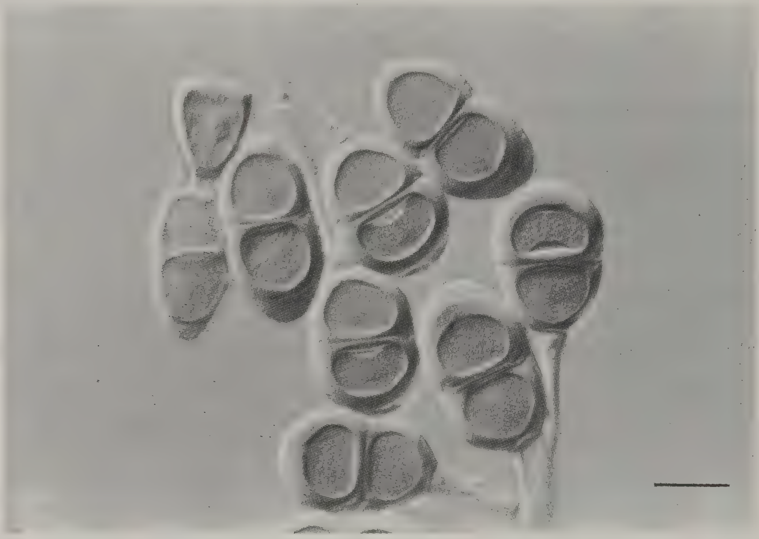

Fig. 4. *Puccinia schoenanthi* Cummins & Guyot, teliospores. Bar = 20 µm.

Uromyces ferganensis Tranzschel & Erem.,
In: Tranzschel, Consp. Ured. U.S.S.R. p. 100. 1939.
II, III on *Stipa caucasica* Schmalh., Golestan province, Golestan National Park, Almeh, 19 July 1991, M. Abbasi (IRAN 10344 F, PUR N1752).
II, III on *S. holosericea* Trin., Mazandaran province, Haraz road, Hareh, 5 Aug. 1993, M. Abbasi, J. Fatehi and Z. Ghanbari (IRAN 10644 F, PUR N1753).

Urediniospores very few, mixed with teliospores, with 6-9 scattered germ pores. Telia epiphyllous, exposed, up to 3 mm in length, blackish brown; teliospores 25-36 x 18-23(-25) µm, ellipsoid, broadly ellipsoid, obovoid or subglobose, attenuate, rounded or flat at the apex, wall 2-2.5 µm thick at the sides, 6-8 µm at the apex, golden- or chestnut-brown, smooth; pedicels colorless, thin-walled, short, rarely to 70 µm long (Fig. 5).
This species occurs on *Stipa* spp. and, so far, is only recorded from the former U.S.S.R. and Morocco (Cummins 1971). This is the first report of this rust from Iran, and *S. holosericea* seems to be a new host. The type specimen of *U. ferganensis* (LE) was not available, but material from Morocco (PUR 88085) listed by Greene & Cummins (1958) was examined. Teliospores in Iranian specimens are darker and slightly narrower.

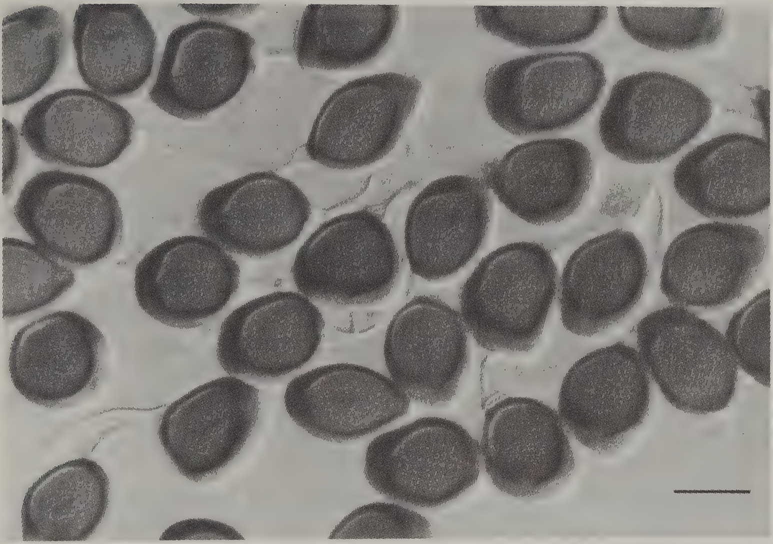

Fig. 5. *Uromyces ferganensis* Tranzschel & Erem., teliospores. Bar = 20 µm.

ACKNOWLEDGEMENTS

We are indebted to Prof. Walter Gams (Utrecht) for writing the Latin diagnosis and acting as presubmission reviewer. The “Plant Pests and Diseases Research Istitute” Tehran and “Studienstiftung Mykologie” Köln gave financial support for a 6 months stay of the senior author in Purdue.

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CONIDIAL AQUATIC FUNGI OF NAINITAL, KUMAUN HIMALAYA, INDIA

S. C. SATI, N. TIWARI and M. BELWAL
Department of Botany, Kumaun University, Nainital-263002 India.

ABSTRACT

Fourteen species of conidial aquatic fungi, viz., *Alatospora flagellata, A. pulchella, Anguillospora furtiva, Dimorphospora foliicola, Dwayaangam dichotoma, Flabellocladia gigantea, Lemonniera alabamensis, L. cornuta, L. pseudofloscula, L. terrestris, Magdalaenaea monogramma, Tetracladium maxilliforme, Tricladiopsis flagelliformis* and *Trinacrium incurvum* collected from high altitude freshwater streams of NainiTal, Kumaun Himalaya, (India) are briefly described. These species were recovered from submerged leaf litter and water foam accumulated at stream barriers. All the species reported hereunder are new to the Indian aquatic fungi and show wide distribution.

Key Words: Aquatic Hyphomycetes / Occurrence and Distribution.

INTRODUCTION

Ingold (1942) recognized a group of fungi which complete their asexual life cycle including vegetative growth, spore production, spore liberation and dispersal on submerged substrates in well aerated waters, as "Aquatic Hyphomycetes". Later, these fungi have also been described as Freshwater Hyphomycetes (Nilsson, 1964), Ingoldian fungi (Webster and Descals, 1981; Bärlocher, 1982), Water-borne Hyphomycetes (Webster and Descals, 1979) and Amphibious Hyphomycetes (Michaelides and Kendrick, 1978; Akridge and Koehn, 1987). These are unique in their habitat and conidial morphology. They sometimes become a dominant group of fungi during the first stage of leaf litter decomposition in fresh water streams (Kaushik and Hynes, 1971; Bärlocher and Kendrick, 1976; Suberkropp and Klug, 1976; Findlay and Arsuffi, 1989).

During the last 50 years several workers have extensively explored these fungi from different parts of the globe. However, in India, a little attention has been paid by the Indian mycologists to these fungi and recorded some species from this sub-continent (Subramanian and Bhat, 1981; Manoharachary and Rao, 1983; Madhusudanrao and

Manoharachary, 1984; Sridhar and Kaveriappa, 1987 & 1989; Sridhar, *et. al.*, 1992; Sati *et. al.*, 1989; Sati and Tiwari, 1990). In Kumaun Himalaya, the conidial aquatic fungi are being explored by Sati and his co-workers and more than 50 species belonging to different genera have been recovered from various habitats (Sati and Tiwari, 1997). In this paper some conidial aquatic fungi collected from high altitude fresh water streams of NainiTal, Kumaun Himalaya (India) are being described along with their wide distribution.

MATERIALS AND METHODS

The study area NainiTal is located in the Kumaun Himalaya, a western part of central Himalaya (29° 22" - 29" N lat. and 79° 28" - 30" E long.) in the north-west of Uttar Pradesh, India. It represents mostly hilly area with a temperate climatic zone. The temperature of this area ranges from 0-10 °C during winter and 15-25 °C during summer with a monsoon pattern of rainfall. There are several perennial freshwater streams passing through forested areas.

Samples of submerged leaves and water foam accumulated at barriers were collected in sterile polythene bags and plastic vials respectively from different streams of NainiTal, Kumaun Himalaya viz., Jeolikot (1200 m a.s.l.), Khurpatal (1600 m a.s.l.), Niglat (1650 m a.s.l.), Gufa Mahadev (1850 m a.s.l.) and Snow View (2250 m a.s.l.) and brought to the laboratory. The leaf litter was washed thoroughly with running tap water for 2-3 hours and then cut into small pieces and placed for incubation at 15±2 °C in sterile Petri dishes (9 cm diam.) containing sterile water. After two days, the incubated leaves were periodically examined under the microscope to detect the conidia of aquatic Hyphomycetes following Ingold (1975), Webster and Descals (1981), Descals and Webster (1982), and Marvanová and Descals (1985). The foam samples were fixed in 5% FAA on the spot to avoid conidial germination and examined under the microscope placing drops on glass slides. Semi-permanent slides of these conidial fungi have been deposited in the Kumaun University Mycological Slide (KUMS) Collection at the Department of Botany, NainiTal.

RESULTS AND DISCUSSION

A total of 14 species of conidial aquatic fungi representing to 10 anamorphic genera have been recovered from different of submerged leaf litter and water foam accumulated at stream barriers. All these species are new to the Indian mycoflora and are being described briefly hereunder. The geographical distribution of these species based on Nilsson (1964), Ingold (1975), Webster and Descals (1981) and other available literature has also been mentioned to show their wide occurrence and distribution.

1. ***Alatospora flagellata*** (J. Gönczöl) Marvanová
   Trans. Brit. Mycol. Soc. 75: 227, 1980.
   = *Clavatospora flagellata* J.Gönczöl
   (Fig.1; Pl. 1.8)

Conidia hyaline, tetraradiate borne on phialides, with a main axis, sharply bent at branch insertion, 27.5-40 x 2.5-3.5 µm, lower part fusiform, 3-4 septate, distal part strongly attenuate, continuous appearing as a branch. Branches two, filiform, curved or straight 11-15 x 2µm, 0-2 septate.

Collected from Snow View and Jeolikot streams on submerged leaf litter of *Quercus leucotrichophora* (KUMS-421). It was a less commonly occurring species in this study and earlier known from Europe and N.America.

2. ***Alatospora pulchella*** Marvanová
Archiv fur Protistenk., 119 :71, 1977
(Fig.2; Pl. 1.9)

Conidia typically tetraradiate borne on phialides, main axis long, 32.5 x 2.5µm, bent at branch insertions, proximal part cylindrical to narrowly clavate, distal part narrowly cymbiform, pendulous, upto 5 septate; branches 2, submedian, similar to the upper part of the axis, 17.5 - 22.5 x 2-3 µm, narrowing at the insertion, upto 2-3 septate.

Collected from Niglat stream in foam samples and Jeolikot stream on submerged leaf litter of *Aesculus indica* (KUMS-424). It was a rare species in occurrence and earlier known from Asia, Australia, S. America and Europe.

3. ***Anguillospora furtiva*** J. Webster & Descals
Can. J. Bot., 71: 1647, 1998.
Teleomorph= *Pezoloma* sp.
(Fig.3; Pl. 1.3)

Conidia solitary, long, hyaline. Mature detached conidia measure 182-320 µm in length and 4-7 µm in width, tapering towards both ends with a truncate scar at the base. The conidia possess 11-15 septa. Conidia detached by disarticulation of the basal septum leaving a dome - shaped conical scar at the tip of the conidiophore.

Collected from Gufa Mahadev, Snow View and Jeolikot streams on submerged leaves of *Quercus incana* (KUMS-0217). It was also a rare species in occurrence and earlier reported from Great Britain.

4. ***Dimorphospora foliicola*** Tubaki
J. Hattori Bot. Lab., 20: 150, 1958
= *Fluminispora ovalis* Ingold
(Fig. 4 a, b; Pl. 1.5)

Conidia unicellular, hyaline, mostly oval pearly, sometimes subglobose or subreniform, containing abundant glycogen. Conidial size vary from 10-20 µm, mostly 12.5-17.5 µm in length and 6 -7.5 µm in width, germinate readily in water by producing a germ tube. Microconidia hyaline, 1-2 µm in diameter, borne in chains of 2-4 conidia on phialides.

Collected from Niglat, Jeolikot and Gufa Mahadev streams on submerged leaf litter of *Acer oblongum* and various other fallen leaves (KUMS-251). It was a common species in occurrence and earlier reported from the Pacific and Great Britain.

5. ***Dwayaangam dichotoma*** Nawawi
Mycotaxon 24: 217, 1985
(Fig. 5; Pl. 1.12)

Conidia tetraradiate, hyaline and multicellular; main axis 10-13.8 x 1-2.5 µm, one to two (mostly one) septate, branched dichotomously at the apex giving rise to 2 very short arms, lying in the same plane with the main axis. Conidia with mainly 4 arms, occasionally 3, rarely 2, 20-28 x 2-4 µm, tapering towards the apex, 4-6 septate, bending slightly outwards.

Collected from Khurpatal stream on submerged decaying leaves of *Polygonum nepalensis* and in foam (KUMS-311). It was less common in occurrence here in Kumaun Himalaya and earlier reported from Malaysia.

6. ***Flabellocladia gigantea*** Nawawi
Trans. Brit. Mycol. Soc. 85: 174, 1985
(Fig. 6; Pl. 1.2)

Conidia tetraradiate, large, with granular contents. The main axis is 47.5 x 4.5 µm, one septate with a bulbous head measuring 6.5 µm in size. Arms three, septa 1-3, 55-65 µm long, 8-10 µm at the swollen base, narrowing at the point of origin and tapering to 4.5 µm at the apices.

Collected from Snow View and Niglat streams in water foams (KUMS-401). It was one of the less frequently occurring species in this study and earlier reported from Malaysia. The conidia slightly differ with the original description of Nawawi (1985). The branch insertion is distinctly constricted on the conidium and attenuation of the elements towards the end is too strong.

7. ***Lemonniera alabamensis*** R. C. Sinclair & Morgan-Jones
Mycotaxon, 9: 469-481, 1979
(Fig. 7; Pl. 1.4)

Conidial primordia spherical, soon branching out into four diverge arms with a distinct spherical or tetrahedral central body, 3-5 µm in diameter. Conidia hyaline, tetraradiate, consisting of 4 divergent branches, 30-45 µm long and 2-4 µm broad at the widest part and gradually tapering to 1 µm at the apex. Arms slightly curved with 1-2 septa.

Collected from Jeolikot stream on submerged leaves of *Aesculus indica* and *Quercus leucotrichophora* and in water foam (KUMS-2110). It was also an uncommonly occurring species of this locality and earlier recorded from North America.

8. ***Lemonniera cornuta*** Ranzoni
Farlowia, 4: 353, 1953.
(Fig. 9; Pl. 1.7)

Conidial primordia initially spherical, later appearing as inverted tetrahedron which soon become flattened and develop into four divergent arms with an indistinct central body. Arms slightly curved 20-50 µm long (mostly 30-40 µm) and 3-5µm wide.

Collected from Niglat, Snow View and Jeolikot streams on submerged leaf litter of *Parthenocissus himalayana* and *Pinus roxburghii*, and in water foam (KUMS-217). It was a very frequently occurring species of this locality. Previously it has been recorded from North America, Great Britain, Europe and the Pacific.

9. ***Lemonniera pseudofloscula*** Dyko
Trans. Brit. Mycol. Soc., 69: 89, 1977
(Fig. 8; Pl. 1.10)

Conidial primordia initially spherical, later becoming tetrahedral, 4-5 arms budding from a central body. Arms septate with a constricted base. Mature detached conidia hyaline, tetraradiate with a distinct subspherical central body 3.5-5 µm in diameter with 4-5 arms, measuring 26-52 x 3.5-6.5 µm, arms tapering with a rounded apex, septa 2-5.

Collected from Niglat, Jeolikot and Snow View streams on submerged needles of *Pinus roxburghii* and various other leaf litter (KUMS-212). It was a very frequently occurring species in the Kumaun Himalayan streams. Its earlier distribution is North America and the Neotropics.

10. ***Lemonniera terrestris*** Tubaki
J. Hatt. Bot. Club. 20: 165, 1958.
= *L. brachycladia* Ingold
(Fig. 10; Pl. 1.1)

Conidial primordia spherical but soon branching out into typically four arms, which diverge tetrahedrally, one branch always grows upwards while the other radiate slightly backwards. Mature detached conidia hyaline, protoplasm pearly, central body absent or indistinct. Arms 3-5 (mostly 4), 10.5-22.5 x 5µm (at the widest submedian portion), tapering towards the apex. Arms nonseptate or occasionally septate.

Collected from Niglat and Jeolikot streams on submerged *Pinus roxburghii* needles and on *Bombax ceiba* leaves (KUMS-2122). It was an infrequent species in this locality, although earlier it is known as world wide in distribution.

11. ***Magdalaenaea monogramma*** G. Arnaud
Bull. Soc. Mycol. Fr., 68: 209, 1952.
(Fig. 11; Pl. 1.11)

Conidia typically multiradiate consisting of a main axis, 36 - 42 μm long and 2 - 3 μm wide, giving rise to a pair of opposite branches, measuring 31.5 - 38.5 x 2 - 3 μm near the base. Each of these branches produces one secondary lateral branch again in the same manner to produce a star shaped conidium with 4-5 arms.

Collected from Niglat stream on unidentified leaves and in water foam (KUMS-301). The conidia of present collection were more close to Ingold (1975). It was one of the rare or uncommon species in occurrence however, earlier reported from Europe and Asia.

12. ***Tetracladium maxilliforme*** (Rostr.) Ingold
Trans. Brit. Mycol. Soc., 25: 372, 1942.
(Fig. 12; Pl. 1.14)

Conidia tetraradiate with a main axis, distally digitiform, proximally subclavate, 11-15 x 2.5-3 μm, 1-3 septate, scar truncate to rounded without basal extension. At 4-7 μm above the scar two lateral ascending elements develop opposite to each other; one of them digitiform, 10 - 15 x 2.6 μm, 0-1 septate, the other branch acicular, initially parallel to the axis and then curving outwards, 7-16 x 1.5-2 μm, 0-1 septate. The digitiform branch bears, at the middle part, an abaxil acicular branch similar to the first, 6-14 x 1-1.5 μm.

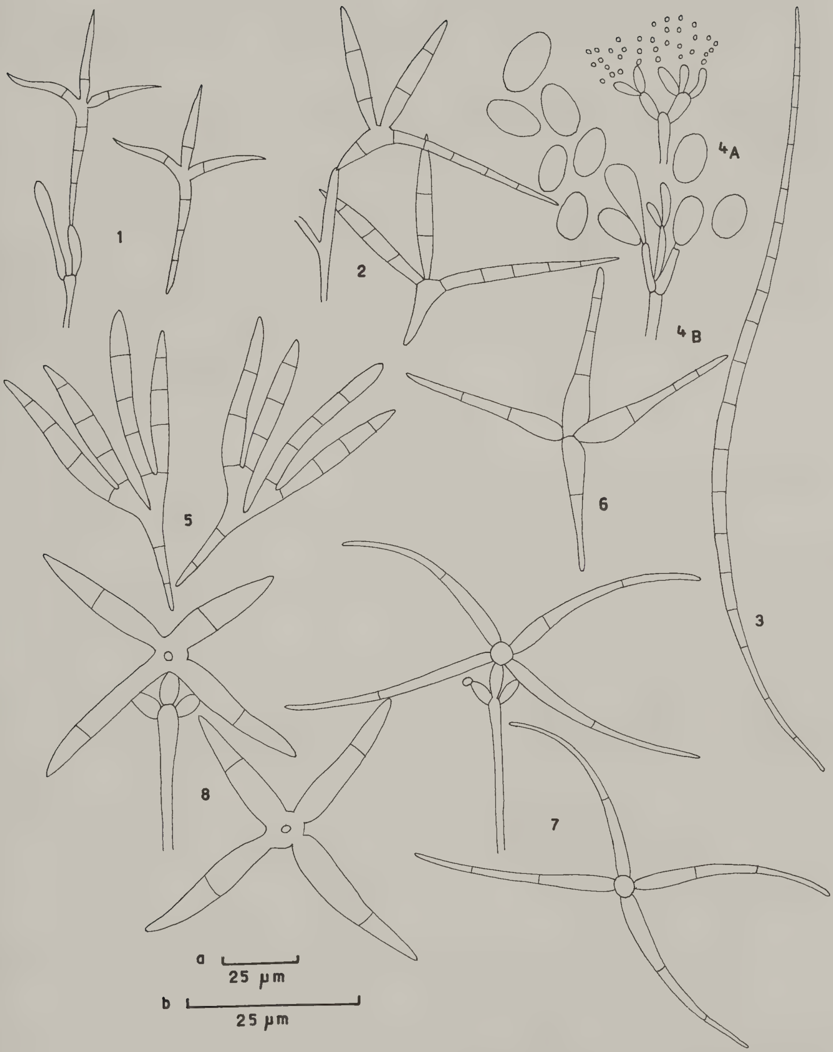
Collected from Snow View stream on submerged leaves of *Quercus leucotrichophora* and *Acer oblongum* (KUMS-315). It was an uncommon species in occurrence but earlier reported from Europe, North America and Great Britain.

13. ***Tricladiopsis flagelliformis*** Descals
Trans. Brit. Mycol. Soc., 78: 405, 1982.
(Fig. 13; Pl. 1.6)

Conidia terminal, solitary, acrogenous, first colourless, later fuscous, consisting of a slightly curved main axis, many septate, 63-140 μm long and 3.5-4.5 μm broad at the widest part, apex attenuate and often bent more or less whip like. Arms 0-2, mostly 1, originating in one plane, 14-56 μm long and 2.6 μm broad at the widest part, much septate, distance between the two arms 20-30 μm.

Collected on submerged leaf litter of *Quercus leucotrichophora* from Niglat stream and in water foam (KUMS-231). It was also infrequently occurring species but earlier recorded from Great Britain.

FIGS.1- 8: 1. *Alatospora flagellata,* 2. *A. pulchella,* 3. *Anguillospora furtiva,* 4. *Dimorphospora foliicola,* a-microconidia; b-macroconidia, 5. *Dwayaangam dichotoma,* 6. *Flabellocladia gigantea,* 7. *Lemonniera alabamensis,* 8. *L. pseudofloscula.* (Fig. 3 and 6 with scale a and; others with scale b).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2
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3
5
6
7
8
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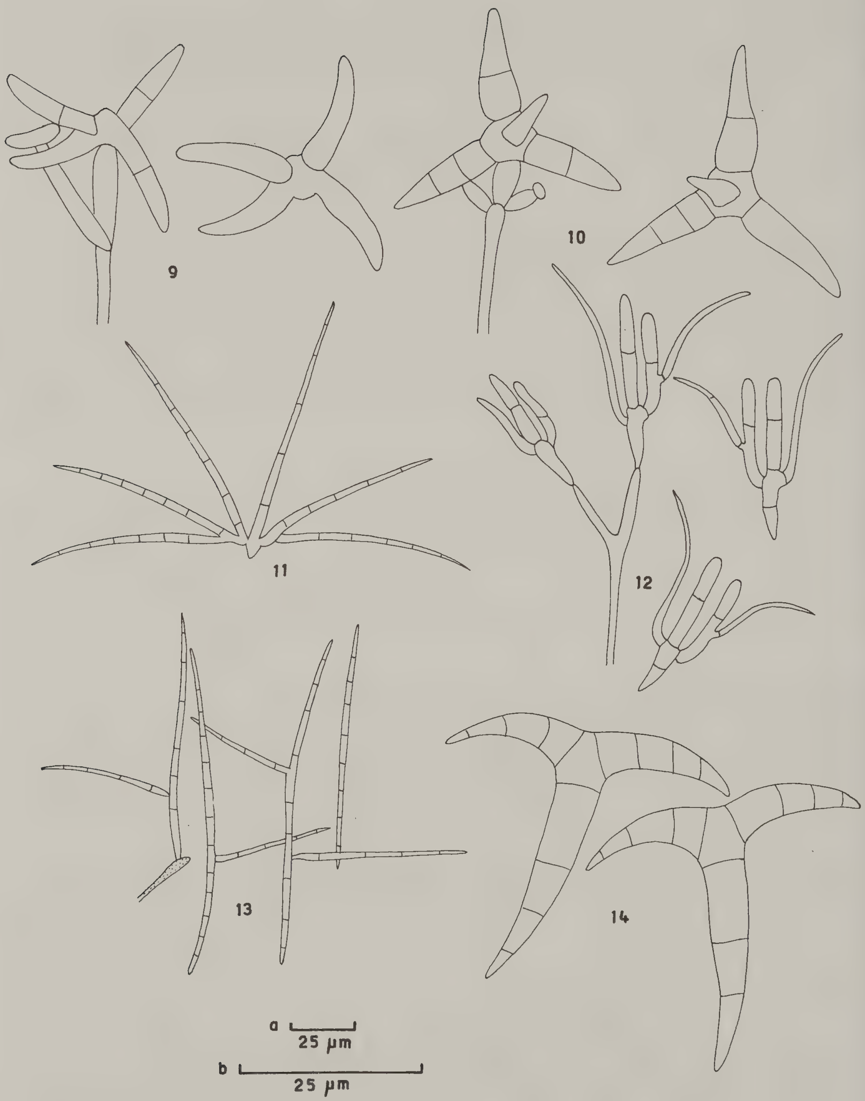
25 μm
b
25 μm


a
25 µm
b
25 µm

14. ***Trinacrium incurvum*** Matsush
Matsushima Mycol. Mem., 7: 70, 1993.
(Fig. 14; Pl. 1.13)

Conidia typically "T" shaped, hyaline; main axis 3-4 septate, fusiform, 35-38 µm long and 5-7 µm broad at the widest part, tapering to 2 µm. Arms 2, septa 2-3, measuring 12-20 µm long and 4-6 µm broad, tapering to 2 µm towards the tips and slightly curved at the subapical region. Arms fused at their point of insertion to the main axis.

Collected from Snow View stream on decaying submerged leaf litter of *Myrsine semiserrata* and in water foam from Niglat (KUMS-311). It was a rare species in occurrence and earlier known from the Neotropics.

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FIGS. 9-14: 9. *Lemonniera cornuta,* 10. *L. terrestris,* 11. *Magdalaenaea monogramma,* 12.*Tetracladium maxilliforme,* 13. *Tricladiopsis flagelliformis,* 14. *Trinacrium incurvum.* (Fig. 13 with scale a and rest with scale b)

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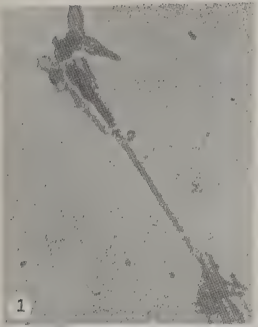
Legends to Plate

Plate1: Photomicrographs of mature conidia- **1**. *Lemonniera terrestris* x700, **2.** *Flabellocladia gigantea* x600, **3**. *Anguillospora furtiva* x300, **4**. *L. alabamensis* x700, **5**. *Dimorphospora foliicola* x900, **6**. *Tricladiopsis flagelliformis* x300, **7**. *L. cornuta* x100, **8**. *Alatospora flagellata* x550, **9**. *A. pulchella* x750, **10**. *L. pseudofloscula* x450, **11**. *Magdalaennaea monogramma* x650, **12**. *Dwayaangam dichotoma* x700, **13**. *Trinacrium incurvum* x600 and, **14**. *Tetracladium maxilliforme* x700.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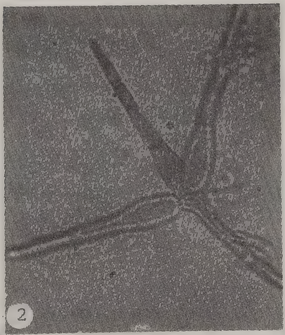
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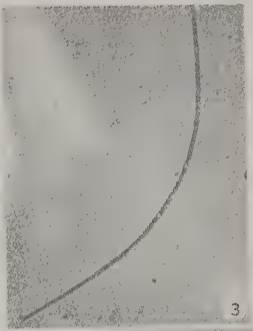
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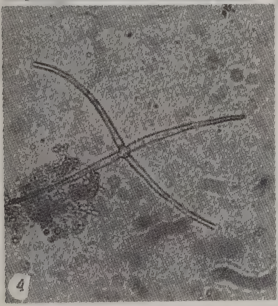
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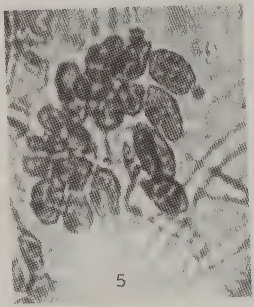
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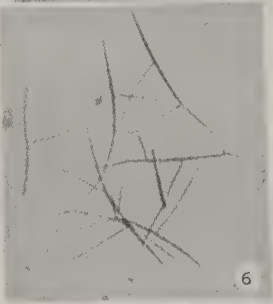
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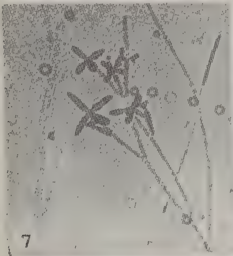
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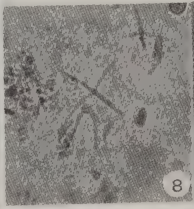
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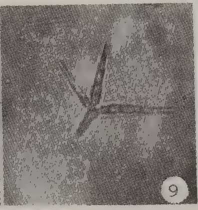
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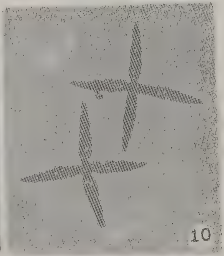
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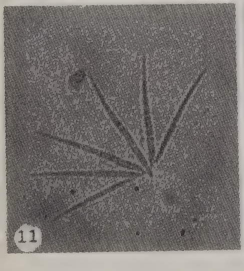
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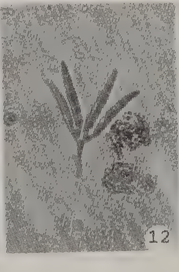
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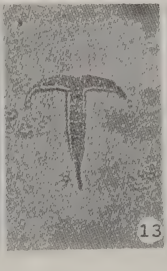
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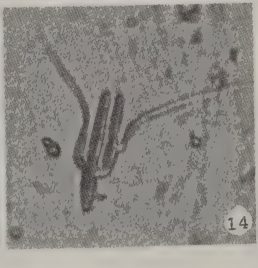
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AQUATIC HYPHOMYCETES FROM CERRADO REGIONS IN THE STATE OF SÃO PAULO, BRAZIL

IRACEMA HELENA SCHOENLEIN-CRUSIUS
Instituto de Botânica, Seção de Micologia e Liquenologia
Caixa Postal 4005, 01061-970 São Paulo, Brazil
E-mail: iracema@crusius.com.br

Abstract

Fourteen taxa of aquatic Hyphomycetes isolated from mixed leaf litter collected from streams located in four cerrado regions in the state of São Paulo are presented. Three taxa have not been recorded previously from Brazil.

Key words: aquatic Hyphomycetes, tropical fungi, aquatic environment.

Introduction

The study of aquatic Hyphomycetes in Brazil began with ecological studies in the Atlantic rainforest in the state of São Paulo. These included investigations of fungal successions on *Ficus microcarpa* L. f. leaves submerged in a lake in the "Parque Estadual das Fontes do Ipiranga", (Schoenlein-Crusius & Milanez, 1989), *Quercus robur* L. leaves in a lake in "Itapecerica da Serra" and a comparison of the aquatic mycota of three types of leaves, *F. microcarpa*, *Q. robur* and *Alchornea triplinervia* (Spreng.) M. Arg. in "Paranapiacaba" (Schoenlein-Crusius et al., 1998; Schoenlein-Crusius & Milanez, 1998) and in the reservoir "Represa do Guarapiranga" (city of São Paulo; Malosso, 1999). The Brazilian "cerrado" is a type of Savannah, characterized mainly by the presence of sandy, acid, aluminum rich soil, frequent fires, and xerophytic vegetation. It is under constant risk of being replaced by cultivated crops, especially in the States of the southeast region. First observations of aquatic Hyphomycetes in the "cerrado" region were performed in little inland streams in the municipalities of Águas de Lindóia (Recanto dos Nefelibatas) and Rio Claro (Schoenlein-Crusius & Milanez, 1990). More extensive surveys were subsequently conducted in streams in the municipality of São Carlos (Rio do Monjolinho and Rio Jacaré-Guaçú), about 300km north of the city of São Paulo (Malosso, 1995; 1999). The results in four regions of the "cerrado" in the state of São Paulo are presented here to contribute to the knowledge of aquatic Hyphomycetes in Brazil.

Materials and methods

Samples of submerged leaf litter (about 50g in 150ml of stream water) were taken in May/1999, September/1999, November/1999, February/2000, May/2000, August/2000 and November/2000 from streams in the following localities (State of São Paulo): "Estação Ecológica de Jataí", "Estação Experimental de Luiz Antonio" (both located at 21° 36'S and 46°47'W), "Estação Ecológica de Itirapina" (22°13'S-47°51'W) and "Estação Experimental e Reserva Biológica de Mogi-Guaçú" (22°15'S-47°09'W). In the laboratory the leaf samples were carefully washed with tap water, cut into 1cm^2 squares, placed in Petri dishes containing distilled sterile water, and incubated at 20°C. After five days, slides were prepared from leaf fragments and examined under the microscope for reproductive structures of aquatic Hyphomycetes (Ingold, 1975; Nilsson, 1962; 1965; Subramanian, 1983).

Results and Discussion

Brief descriptions, sites of isolation and comments on the fourteen taxa are given.

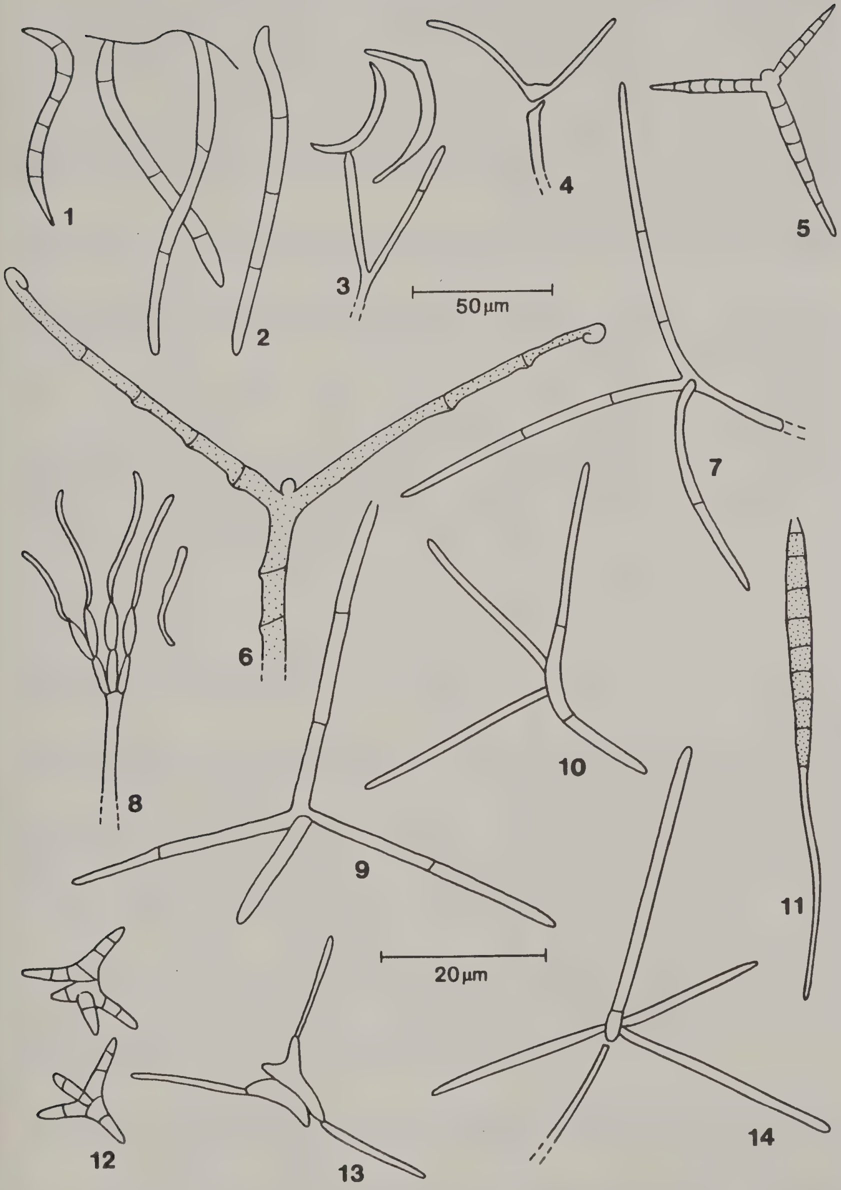
1. *Anguillospora crassa* Ingold (Fig. 1). Thalloconidia terminal, simple, sigmoid, sinuous, 110-380x7-12μm, septate, hyaline, liberated by disjunction of a connecting cell.
Occurrence: Itirapina (September/99) and Luís Antônio (May/99).
Comments: *A. crassa* has been isolated from submerged leaf litter from streams in the municipalities of Rio Claro, Águas de Lindóia (Schoenlein-Crusius & Milanez, 1990) and São Carlos (Malosso, 1999). In the Atlantic Rainforest of Paranapiacaba (municipality of Santo André), the taxon was isolated from submerged leaves of *Alchornea triplinervia* (Schoenlein-Crusius & Milanez, 1998).

2. *Anguillospora longissima* (Sacc. et Sydow) Ingold (Fig. 2). Thalloconidia, terminal, simple, sigmoid, sinuous slightly curved, 130-300x5-10μm, septate, hyaline, percurrent extensions present at the basis of the spore.
Occurrence: Mogi-Guaçú (September/99), Jataí (September/99, February/00, August/00, November/00), Luís Antonio (February/00, May/00, August/00), Itirapina (May/00).
Comments: The taxon was isolated from leaves of *Quercus robur* L. and *Ficus microcarpa* L. f. (Schoenlein-Crusius et al., 1992) submerged in the Atlantic Rainforest of Paranapiacaba (municipality of Santo André), and also from leaves of *F. microcarpa* in an artificial lake in the "Parque Estadual das Fontes do Ipiranga" in the city of São Paulo (Schoenlein-Crusius & Milanez, 1989). In the same municipality, *A. longissima* was isolated from leaf litter from a polluted dam "Represa do Guarapiranga" (Malosso, 1999). In the inland, the taxon was found on leaf litter submerged in streams (Rio do Monjolinho and Rio Jacaré-Guaçú) in the municipality of São Carlos (Malosso, 1999).

3. *Camposporium pellucidum* (Grove) Hughes (Fig. 11). Thalloconidia terminal, simple, rod-like, 95-130x8-12μm, 4-5 transverse septa, dark brown, with a terminal hyaline, slightly curved projection.
Occurrence: Mogi-Guaçú (May/99, November/99, May/00), Jataí (May/99, November/99), Luís Antônio (May/99).
Comments: The species was isolated once from *Q. robur* leaves, submerged in a lake in the municipality of Itapecerica da Serra (Schoenlein-Crusius et al., 1992). It was also obtained from the same leaf species, together with leaf litter of *A. triplinervia*, in a stream of the Atlantic Rainforest of Paranapiacaba (Schoenlein-Crusius et al., 1992). It is the first time that it has been isolated in a cerrado region.

4. *Campylospora chaetocladia* Ranzoni (Fig. 13). Thalloconidia terminal, branched, faulted aspect, 60-100x4-6μm, non-septate, hyaline, formed by a differentiated bent cell of the conidiophore, with ends that grow simultaneously into four long lateral spines.
Occurrence: Itirapina (August/00).
Comments: This species was isolated from mixed leaf litter in a stream in the municipality of Rio Claro (Schoenlein-Crusius & Milanez, 1990).

5. *Flabellospora crassa* Alasoadura (Fig. 5). Thalloconidia terminal, branched, 40-70x4-11μm, 3-5 septa, hyaline, presence of a very small central stalk, projecting four to five arms with acute ends.
Occurrence: Itirapina (February/00).
Comments: The species was isolated from mixed leaf litter in the municipality of Rio Claro and from leaves of *Q. robur* submerged in a lake in the municipality of Itapecerica da Serra (Schoenlein-Crusius et al., 1990).



Figs. 1-14. Spores of aquatic Hyphomycetes: 1. *Anguillospora crassa*; 2. *A. longissima*; 3. *Lunulospora curvula*; 4. *L. cymbiformis*; 5. *Flabellospora crassa*; 6. *Ingoldiella hamata*; 7. *Tetrachaetum elegans*; 8. *Flagellospora penicillioides*; 9. *Lemonniera aquatica*; 10. *Tricladium gracile*; 11. *Camposporium pellucidum*; 12. *Tripospermum myrti*; 13. *Campylospora chaetocladia*; 14. *Triscelophorus monosporus*.

6. *Flagellospora penicillioides* Ingold (Fig. 8). Phialoconidia, terminal, simple, sigmoid, slightly curved, 47-60x2-3μm, 0-1 septum, formed on a *Penicillium*-like conidiophore.
Occurrence: Luís Antônio (August/00 and November/00)
Comments: This is the first record of this species from Brazil. According to Ingold (1975), it is widely distributed.

7. *Ingoldiella hamata* Shaw (Fig. 6). Conidia with clamp connections, irregularly branched, variable size (200 to 400μm), 3-5 arms, slightly pigmented (brown to light reddish brown), conspicuously hooked ends.
Occurrence: Itirapina (november/00)
Comments: this species is the anamorph state of the Basidiomycota *Cerrena* sp. (Aphyllophorales) and this is the first observation from Brazil.

8. *Lemonniera aquatica* de Wildemann (Fig. 9). Phialoconidia terminal, branched, tetraradiate with four straight arms, 25-75x2,8-4,5μm, non-septate, hyaline, formed on a *Penicillium*-like conidiophore.
Occurrence: Luís Antônio (September/99, November/99, November/00), Mogi-Guaçú (May/00 and November/00).
Comments: The species has been isolated from leaves of *F. microcarpa* submerged in a lake in the "Parque Estadual das Fontes do Ipiranga" (Schoenlein-Crusius & Milanez, 1989) and from mixed leaf litter in the dam "Represa do Guarapiranga" (Malosso, 1999), both in the city of São Paulo. In the Atlantic Rainforest it has been isolated from *F. microcarpa* leaves, submerged in a stream in Paranapiacaba (Schoenlein-Crusius et al., 1992), and from leaves of *Q. robur* submerged in a lake in the municipality of Itapecerica da Serra (Schoenlein-Crusius et al., 1992). This is the first time that this species has been isolated in a cerrado region.

9. *Lunulospora curvula* Ingold (Fig. 3). Thalloconidia terminal, simple, lunulate, 50-120x4-8μm, non-septate, hyaline, with a distinct attachment scar next to the end of the main axis.
Occurrence: Mogi-Guaçú (May/99, February/00, May/00, August/00), Jataí (May/99, May/00, August/00), Luís Antonio (May/99, September/99, May/00, Ago/00), Itirapina (November/99, February/00, May/00).
Comments: *L. curvula* is one of the most frequently reported species, being isolated from submerged leaf litter in several municipalities (Rio Claro, Águas de Lindóia, Paranapiacaba) in the State of São Paulo (Schoenlein-Crusius & Milanez, 1990). It was also observed during the fungal succession on leaves of *Ficus microcarpa* in the "Parque Estadual das Fontes do Ipiranga", city of São Paulo (Schoenlein-Crusius & Milanez, 1989), leaf litter of *Q. robur* in the municipality of Itapecerica da Serra (Schoenlein-Crusius et al., 1992) and from *Alchornea triplinervia* leaves in a stream in Paranapiacaba (Schoenlein-Crusius & Milanez, 1998), all localities situated in the Atlantic Rainforest. Malosso (1999) isolated the taxon from mixed leaf litter in the dam "Represa do Guarapiranga" in the city of São Paulo, and also from leaf litter taken from streams (Rio do Monjolinho and Rio Jacaré-Guaçú) in the municipality of São Carlos.

10. *Lunulospora cymbiformis* Miura (Fig. 4). Thalloconidia terminal, simple, L-shaped, slightly sigmoid, 55-110x4-6μm, septated, hyaline, with conspicuous and inflated detachment scar.
Occurrence: Jataí (May/00) and Luís Antonio (November/00).
Comments: *L. cymbiformis* is not a common species and has only recently been isolated from leaf litter submerged in a stream (Rio do Monjolinho) in the municipality of São Carlos (Malosso, 1999).

11. *Tetrachaetum elegans* Ingold (Fig. 7). Thalloconidia, terminal, branched, tetraradiate, 3-4 arms, 100-300x2,5-4,3μm, septate, hyaline, developing at the top of an unbranched differentiated hypha, released by a separating cell.
Occurrence: Itirapina (September/99).
Comments: The species was observed in mixed leaf litter collected in the municipality of Rio Claro (Schoenlein-Crusius & Milanez, 1990). However it has more often been reported from the Atlantic Rainforest, on submerged leaves of *Ficus microcarpa*, *Quercus robur* and *Alchornea triplinervia* (Schoenlein-Crusius et al., 1992; Schoenlein-Crusius & Milanez, 1998).

12. *Tricladium gracile* Ingold (Fig. 10). Thalloconidia terminal, branched, L-shaped, with a stout main axis (100-120μm) and two straight lateral branches (60-80um), non-septate and hyaline.
Occurrence: Mogi-Guaçú (February/00).
Comments: This is the first record from Brazil. According to Ingold (1975) the species is frequent in Britain.

13. *Tripospermum myrti* (Lindemann) Hughes (Fig. 12). Asymmetric terminal thalloconidia with 4-5 thick branches, 30-40μm, 3-4 septa, hyaline, arising laterally as an outgrowth of the mycelium.
Occurrence: Mogi-Guaçú (May/99), Itirapina (May/00 and August/00).
Comments: This species was isolated from mixed leaf litter submerged in Rio do Monjolinho in the municipality of São Carlos (Malosso, 1999).

14. *Triscelophorus monosporus* Ingold (Fig. 14). Thalloconidia terminal, branched, tetraradiate, 30-65x3-4μm, non-septate, hyaline, percurrent growth of the four branches, remaining knob on the main axis
Occurrence: Luís Antonio (September/99, May/00, November/00), Jataí (November/99, November/00), Mogi-Guaçú (February/00, November/00), Itirapina (May/00, November/00).
Comments: This is one of the most frequently mentioned aquatic Hyphomycete in Brazilian studies, being isolated in submerged leaves from many localities of the State of São Paulo (Schoenlein-Crusius & Milanez, 1990), including Rio do Monjolinho and Rio Jacaré-Guaçú in the municipality of São Carlos (Malosso, 1999). It was isolated from *Q. robur*, *F. microcarpa* and *A. triplinervia* leaves submerged in a stream in the Atlantic Rainforest of Paranapiacaba (Schoenlein-Crusius et al., 1992; Schoenlein-Crusius & Milanez, 1998) and from leaves collected from a dammed reservoir (Represa do Guarapiranga) in the city of São Paulo (Malosso, 1999).

Acknowledgments

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MYCOTAXON

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MUSCODOR ROSEUS ANAM. SP. NOV., AN ENDOPHYTE FROM GREVILLEA PTERIDIFOLIA

Jeerapun Worapong,[1] Gary Strobel,[1] Bryn Daisy,[1] Uvidelio F. Castillo,[1] Gary Baird,[2] and W.M. Hess[3]

[1]Department of Plant Sciences, Montana State University, Bozeman, Montana, 59717.

[2]Department of Biology, Brigham Young University-Idaho, Rexburg, Idaho, 83460-1100.

[3]Department of Botany and Range Science, Brigham Young University, Provo, Utah, 84602.

ABSTRACT

Muscodor roseus anam. sp. nov. is described as a deuteromycetous (mycelia sterilia) endophytic fungus bearing molecular relatedness to the ascomyceteous genus *Xylaria*. The fungus is characterized by producing a pinkish, felt-like mycelium on PDA and other media. No fruiting structures or spores of any kind have been found when the fungus has been incubated on multiple synthetic and natural media containing steriled pieces of the host plant (*Grevillea pteridifolia*) or other plant materials. The hyphae (0.8 – 3.6 μm dia.) grow in multiple rope-like strands and these can intertwine to make more complex structures. Frequently seen are tight perfect coils of hyphae (20 μm dia.) containing many loops of a single fungal hypha. The fungus is related to Xylariaceae by virtue of 96-98% similarities of its 18S rDNA (2055 bp) to representative members of this group. Phylogenetic analysis based on 18S sequences showed that *M. roseus* is taxonomically related to *Muscodor albus*. *Muscodor roseus,* having two isolates recovered and deposited, also produces a mixture of volatile antibiotics having a musty odor as does *M. albus.*

Keywords: Xylaria, endophyte, mycelia sterilia, 18S rDNA, volatile antibiotics

INTRODUCTION

Recently, we have described a novel endophytic fungus *Muscodor albus* that was isolated from the small branches of a cinnamon tree (*Cinnamomum zeylanicum*) growing in Honduras. The fungus was described as a deuteromycete belonging to the mycelia sterilia since it bore no fruiting bodies or spores (Worapong et al., 2001). Using molecular techniques, the sequences of 18S rDNA as well as ITS1, 5.8S and ITS2 regions were obtained. These were then compared with other comparable sequences of fungi deposited in GenBank. Ultimately, it was possible to show that *M. albus* was related but not identical to other ascomyceteous fungi belonging to the genus *Xylaria* and thus, a binominal was established for it. One of the unique biological features of *M. albus* is that it produces volatile antibiotics that are extremely effective in killing many plant pathogenic fungi and bacteria as well as microorganisms that are pathogenic to humans (Strobel et al., 2001). The volatiles of *M. albus* were analyzed by gas chromatography and mass spectroscopy (GC/MS) and then the compounds were confirmed after they were acquired or synthesized and also subjected to GC/MS. Ultimately, an artificial mixture of the volatiles of *M. albus* was used in an atmosphere containing a suite of test microorganisms. This atmosphere virtually mimicked the inhibitory and killing effects of the fungus itself (Strobel et al., 2001).

The volatiles of *M. albus* were also tested against plants infested with pathogenic fungi. The volatiles, themselves, had no detrimental effects on higher plants that were tested. However, it was possible to demonstrate a 100% control of covered smut of barley using the volatiles to treat seed infested with *Ustilago hordei*. Thus, because of the potential practical importance of volatile antibiotic producing fungi it was deemed important to determine if other organisms in this group exist in nature.

Using standard techniques for the isolation of endophytic fungi, as well as the use of the volatiles of *M. albus* as a selection tool in culture, at least two more volatile antibiotic producing endophytes were isolated. These organisms were obtained from two separate tree species native to Australia. These two fungal cultures bore similarities to *M. albus* in that they made no fruiting structures in culture, produced no spores, made a musty odor and were inhibitory or lethal to many microorganisms. However, by the same token, these organisms possessed cultural, chemical, and molecular biological characteristics that differed from *M. albus*. Thus, the intent of this report is to establish that these fungi, based on their unique features, belong to a new species of *Muscodor*. The name proposed is *Muscodor roseus*.

MATERIALS AND METHODS

Fungal Isolation

Several small limbs of a Fern-leafed Grevellia (*Grevillea pteridifolia*) 12° 59' 39" South and 132° 28' 50" East were obtained in the Northern Territory of Australia. Small pieces of inner bark, sapwood and outer xylem tissues of some small limbs (0.5 cm dia.) were aseptically removed and placed on Petri plates containing water agar (Strobel et al., 1996). After incubation for several days, hyphal tips of developing fungi were aseptically removed and placed on potato dextrose agar (PDA). In addition, after 7 days, fungal colonies were transferred to gamma irradiated carnation leaves (0.5 x 0.5 cm) and other plant materials to encourage spore production. Of several fungi that were isolated, the one of greatest interest, because of its musty odor, was an isolate designated "A3-5."

Another fungus was obtained from the small limbs of an Australia native tree, the Ironwood (*Erythophelum chlorostachys*) at 15° 29' 29" South and 131° 23' 12" East. This endophyte was isolated by the novel method of using the volatiles of *M. albus* as a selection tool. This was done by placing plant material, from which endophytes are to be isolated, in the same agar plate as a rapidly growing two-week old culture of *M. albus*. Then, the only organisms developing from the plant material were the ones resistant to *M. albus*, which are possibly other volatile antibiotic producers or relatives of *M. albus* in the xylariaceous group (Strobel et al., 2001). The most commonly isolated endophytes from this tree were *Pestalotiopsis* spp. and other *Xylaria* spp. However, one isolate appeared that demonstrated an ability to produce volatile antibiotics and it was designated "A-10."

Scanning Electron Microscopy

In order to do scanning electron microscopy of isolates "A3-5 and A-10," agar pieces, leaves and other plant parts supporting fungal growth were placed into distilled water with Triton X 100 (wetting agent) and aspirated for 5 min (Strobel et al., 2000). The fungal preparation was then placed into 2% glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.2-7.4) and left overnight. The next day they were washed in six 15-min-changes of water buffer, followed by three 15-min-changes in 10% ethanol, four 15-min-changes of 30% ethanol, five 15-min-changes of 50% ethanol and left for two days in 70% ethanol. They were then rinsed in five 15-min-changes of 95% ethanol and five 15-min-changes in 100% ethanol. The dehydration process was done slowly to discourage the process of hyphal shriveling which occurs during rapid dehydration. Ultimately, the fungal material was critical point dried, gold sputter coated and examined with a JEOL 6100 scanning electron microscope (SEM).

Fungal Growth and Storage

The fungi were also grown on a number of different media including Tryptic Soy Broth Agar (TSBA), Corn Meal Agar (CMA), Malt Agar (MA), Potato Dextrose Agar (PDA), Difco Laboratories, Detroit, Mich. Also, in order to encourage spore production, the fungi were inoculated onto Petri plates containing water agar with individual samples of steriled small limbs of the host plant material or gamma irradiated carnation leaves.

In order to determine how to best store isolates A3-5 and A-10, several conditions were tried. The fungus was grown on sterilized Whatmann No. 1 filter paper discs that were placed on the surface of PDA in Petri plates. The fungus was inoculated as an agar plug in the middle of the filter paper disc on the PDA plate. The plate was incubated for 14 days at 22°C. The paper disc was then removed and placed in a laminar flow hood under sterile conditions for 1 day, or until the paper with its fungal mycelium was dry. The paper disc was then cut into many pieces and stored at 23°C, 4°C, 0°C and -70°C. Also, agar plugs containing the fungus were placed in sterile distilled water and stored at 4°C. In another set of test conditions, mycelial pieces growing on agar were placed in 15% glycerol and stored at -70°C. In each test, fungal viability was determined by placing the mycelial fragments on a PDA plate and examining it for fungal growth after 3-4 days.

Fungal DNA Isolation.

For DNA isolation, all fungi were grown in potato dextrose broth in 1.5 ml for 18 to 24 h at 23°C. The mycelium was harvested by centrifugation and washed twice with sterile ddH$_2$O. Total genomic DNA was extracted by the methods of Lee and Taylor (1990).

Amplification of 18S ribosomal DNA.

Partial nucleotide base pair fragments of the 18S rDNA gene from each fungus was amplified via the polymerase chain reaction (PCR) as a single fragment with the primer UK4F (5' CYG-GTT-GAT-CCT-GCC-RG 3') and UREV (5' GYT-ACC-TTG-TTA-CGA-CTT 3'). PCR was performed in a 50 µl reaction vial containing 0.1 µg genomic DNA, 0.4 µM each primer, 0.16 mM four dNTPs and 5u *Taq* polymerase (Promega) in a buffer of 10 mM tris-HCl (pH 9.0 at 25°C), 50 mM KCl, 3 mM $MgCl_2$, 0.1% Triton X 100. Amplification was for 30 cycles (45 s at 94.5°C, 45 s at 53.5°C, 90 s at 72.5°C).

Amplification of Internal Transcribed Space sequences (ITS) and 5.8S rDNA.

The ITS regions of the test fungus were amplified using PCR and the universal ITS primers ITS5 (5' GGA-AGT-AAA-AGT-CGT-AAC-AAG-G3') and ITS4 (5' TCC-TCC-GCT-TAT-TGA-TAT-GC 3') (White et al., 1990). PCR was performed in a 50 µl reaction containing 0.1 µg genomic DNA, 0.4 µM each primer, 0.16 mM four dNTPs and 5u *Taq* polymerase (Promega) in a buffer of 10 mM tris-HCl (pH 9.0 at 25°C), 50 mM KCl, 3 mM $MgCl_2$, and 0.1% Triton X 100. PCR cycling conditions consisted of denaturation at 94°C for 1.5 min, annealing at 55°C for 2.5 min, and extension at 72°C for 3 min for 40 cycles, with a final extension at 72°C for 10 min (Willits and Sherwood, 1999). The PCR products were gel purified and desalted using the QuickStep PCR purification kit (Edge Biosystems).

Cycle Sequencing 18S ribosomal DNA, ITS Regions and 5.8S rDNA.

PCR product (10-40 ng) was sequenced using ABI prism BigDye terminator chemistry (Perkin-Elmer) and the respective primers (Table 1). Sequencing conditions were 25 cycles of 96 for 10 sec, 50 for 5 sec and 60 for 4 min. Isopropanol precipitation was used to purify extension products (Protocol ABI Prism BigDye Terminator Cycle Sequencing Ready Reaction Kit, 1998). The reactions were resolved on an ABI prism 310 Genetic Analyzer (Perkin-Elmer). Nucleotide sequences were determined on both strands with a Sequencer program (Gene Codes Corporation, Inc., 1995).

Table 1. Primers used for determining 18S rDNA and ITS and 5.8S nucleotide sequences of various fungal isolates (see Worapong et al., 2001).

Primers	Sequences from 5' to 3'
UK4F	5' CYG GTT GAT CCT GCC RG 3'
NE32F1	5' CTG CCC TAT CAA CTT TCG 3'
NE32F2	5' CTC GTA GTT GAA CC T TGG 3'
NE32F3	5' AGA CTA ACT ACT GCG AAA GC 3'
NE32F4	5' GGA TTG ACA GAT TGA GAG C 3'
NE32F5	5' GTA AGC GCA AGT CAT CAG 3'
UREV	5' GYT ACC TTG TTA CGA CTT 3'
NE32R1	5' AGA CCC TGC CAT CGA AAG 3'
NE32R2	5' TTG GAG CTG GAA TTA CCG 3'
NE32R3	5' GCT TTC GCA GTA GTT AGT C 3'
NE32R4	5' GGT CTC GTT CGT TAT CGC 3'
NE32R5	5' AGC ACG ACG GAG TTT AAC 3'

See Errata

ITS1	5' TCC GTA GGT GAA CCT GCG G 3'
ITS2	5' GCT GCG TTC TTC ATC GAT GC3'
ITS3	5' GCA TCG ATG AAG AAC GCA GC3'
ITS4	5' TCC TCC GCT TAT TGA TAT GC3'
ITS5	5' GGA AGT AAA AGT CGT AAC AAG G3'

Searching and Comparison 18S rDNA and ITS1&2 sequences.

Both 18S rDNA and ITS1&2 sequences of culture collection "A3-5" were submitted to GenBank with serial numbers **AY034664** and **AY034665**, respectively, while the 18S rDNA of isolate "A-10" was assigned **AYO49023**. In addition, both 18S rDNA and ITS1&2 sequences of "A3-5" also were searched or compared with other fungal sequences under BLAST 2.2.1 (Altschul et al., 1997), a search of NCBI at the web site http://www.ncbi.nlm.nih.gov/BLAST. Comparison and alignment sequences were done by using CLUSTALW version 1.7 (Thomson and Gibson, 1997) and manually aligned afterward.

Phylogenetic analysis of the aligned 1708 bp of partial 18S rDNA sequences was performed using the maximum parsimony analysis of the Phylogeny Using Parsimony Analysis (PAUP*) program version 4.0b4a (Swofford, 1999). The number of parsimony-informative characters are 190, and 1448 characters and are constant. The phylogenetic analysis was performed on eighteen taxa, including reference taxa. The reference taxa were Traphinales: *Taphrina wiesneri* (GenBank accession number D12531), *Taphrina deformans* (U00971) and *Taphrina pruni-subcordatae* (AB000957). The remaining fifteen species were *Muscodor albus* (AF324337), *Muscodor roseus* (AY034664), *Xylaria carpophila* (Z49785), *X. curta* (U32417), *X. hypoxylon* (U20378), *X. polymorpha* (AB014043), *Xylaria* sp. (AB014042), *Rosellinia necatrix* (AB014044), *Poronia punctata* (AF064052), *Daldinia concentrica* (U32402), *Hypoxylon fragiforme* (AB014046) and *Hypoxylon atroroseus* (U32411), *Pestalosphaeria hansenii* (AF242846) *Discostroma tricellular* (AF346546) and *Amphisphaeria* sp. (AF346545). The bootstrap analysis was set as the following: 100 replications, tree bisection-reconnection branch swapping, random sequence addition. All characters were weighted equally.

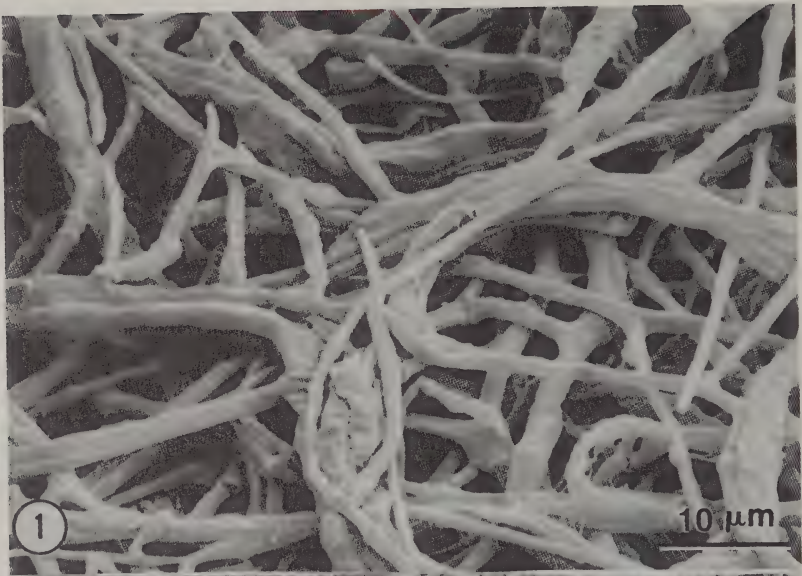
RESULTS AND DISCUSSION

Fungal Taxonomy

Muscodor roseus Worapong, Strobel, and W.M. Hess anam. sp. nov. (Figs. 1-4).

***Fungus** endophyticus in natura in speciebus duabus australiensibus arborum et est deuteromycete myceliis sterilibus pertinens. **Coloniae fungales** tarde crescentes et pallidae roseae coloratae mediis omnibus. **Mycelium** in PDA in 3-4 hebdomadibus patellam tegens et odorem mucidum validum proprie proprietatibus antibioticis producens. Mycelium vetiores (4-6 hebdomates aetate) sectionibus cuneiformibus erumpentibus loco inoculationis vulgo radiantibus. **Hyphae** (0.8-3.6 μ dia.) convolventes et fila funiformia complexa spiris (20 μm) aliquando perfectis efficientes.*

Fungus in nature is endophytic on at least two tree species in Australia. It is a deuteromycete belonging to mycelia sterilia. Fungal colonies are slow growing and



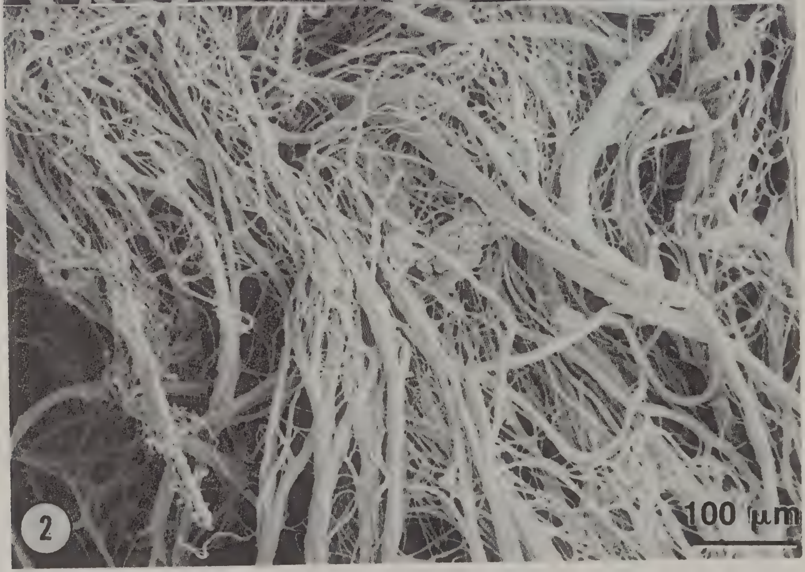
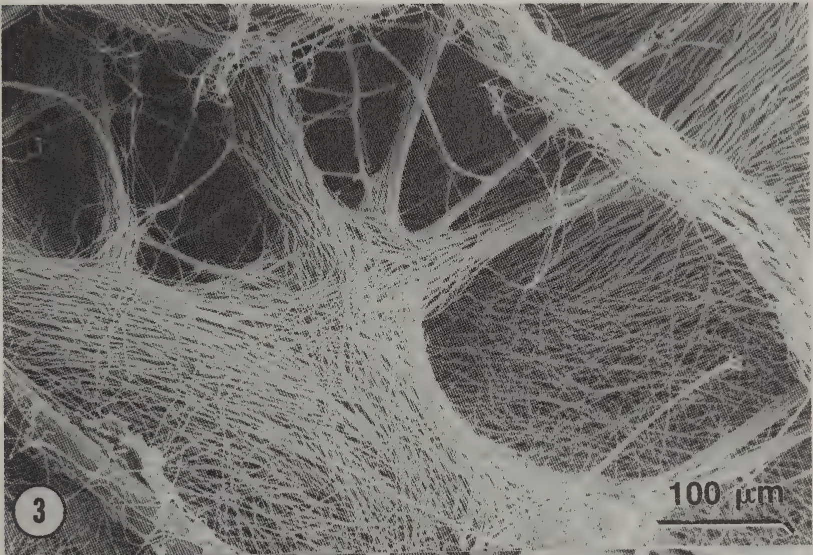


Fig. 1. Hyphae of *M. roseus.* The diameter of the hyphae varies dramatically. The bar equals 10µm.

Fig. 2. The intertwining of the hyphae of *M. roseus*, which is a characteristic feature for this organism. The bar equals 100µm.



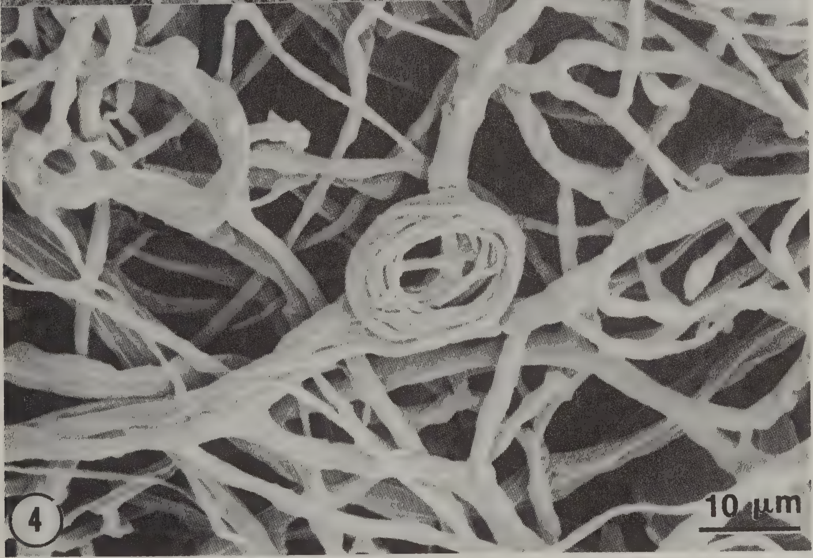


Fig. 3. Intertwined hyphae of *M. roseus* making more complex structures in culture. The bar equals 100 µm.

Fig 4. The unusual appearance of the coiling of fungal hyphae which commonly appears in cultures of *M. roseus*. The bar equals 10 µm.

lightly rose colored on all media. No spores were produced on any medium tested. **Mycelium** on PDA covering the plate in 3-4 weeks and characteristically producing a musty odor which possesses antibiotic properties. The older mycelium (4-6 weeks) commonly develops erumpant pie-shaped sectors radiating from the original point of inoculation. **Hyphae** (0.8-3.6 μm dia.), intertwining, making complex rope like strands, and occasionally perfect coils (20 μm dia.).

Holotype: Isolate "A3-5" of *M. roseus* is endophytic on *Grevillea pteridifolia.* Isolate "A-10" of *M. roseus* is endophytic on *Erythophelum chlorostachys.* Both plants are tree species native to Australia and were collected in the Northern Territory. Specimens were collected by Gary and Suzan Strobel. The two fungal isolates are deposited in the Montana State University Herbarium (MONT) as Strobel *M. roseus* A3-5 and *M. roseus* A-10. Living cultures under the same designation are in the Montana State University Mycological collection and designated deposit numbers of 2098 and 2099, respectively.

Both 18S rDNA and ITS1&2 sequences of *Muscodor roseus* A3-5" were submitted to GenBank with serial numbers **AY034664** and **AY034665**, respectively. The 18S rDNA of *M. roseus* isolate "A-10" was assigned **AYO49023**. The designated holotype is Strobel *M. roseus* A3-5 and the designated paratype is Strobel *M. roseus* A-10. Both have been deposited in the Montana State University herbarium.

Telomorph: unknown, but may ultimately be shown to be found in the Xylariaceae because of the strong homology to the 18S rDNA of established species in this group.

Etymology: The genus name, *Muscodor*, for this fungus is taken from the Latin which means musty. This is consistent with the nature of the odor that is produced by cultures of this fungus. The species name is the Latin *roseus* for pink, the common color of this organism in culture.

Molecular Biology of *Muscodor roseus*

It has been well demonstrated that the molecular characteristics of an organism are unique to it and can be used to help in classification, especially when critical structures (spore production) or other features are missing. Thus, the phylogenetic character mapping method combined with morphological data can assist in fungal identification. Commonly, the rDNA genes are targeted for taxonomic purposes because they are highly conserved (Bruns et al., 1991; Guarro et al., 1999; and Mitchell et al., 1995). In addition to its 18S rDNA, the ITS1&2 sequences are also conserved. After searching partial 18S rDNA sequences of *M. roseus* "A3-5" (2055 bp) with data in GenBank under BLASTN 2.2.1, the results showed 100% similarities with 2089 bp of *Muscodor albus* (AF324337) from site 1-981, 1319-2048, and 98% similarities with 982 bp of *Xylaria polymorpha* (AB014043) and *Hypoxylon fragiforme* (ABO14046), and 97% similarities with 982 bp of *Rosellinia necatrix* (AB014044). In addition, isolate "A-10" possesses 99% sequence similarity of its 18S rDNA (2051 bp) to that of isolate "A3-5."

On the other hand, comparative analysis of the ITS1&2 and 5.8S rDNA sequences of *M. roseus* "A3-5" hit ITS1&2 of *Muscodor albus* (AF324337), *X. arbuscula* CBS 452.63 (AF163029) and CBS 454.63 (AF163028), *X. enteroleuca*

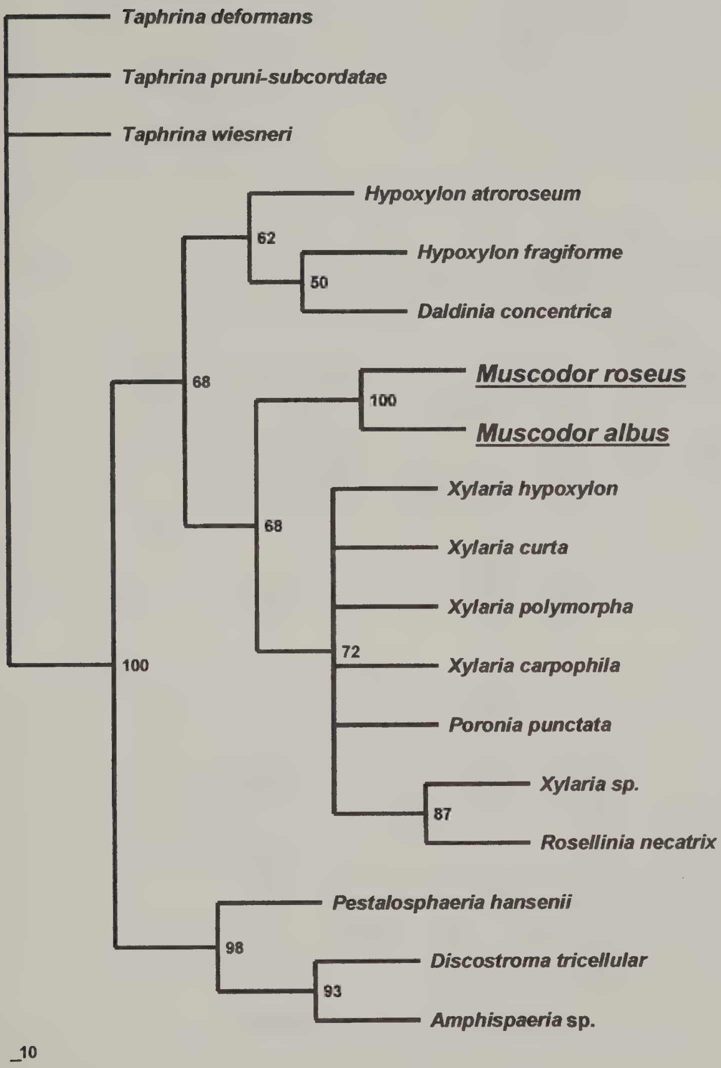

Taphrina deformans
Taphrina pruni-subcordatae
Taphrina wiesneri
Hypoxylon atroroseum
62
Hypoxylon fragiforme
50
Daldinia concentrica
Muscodor roseus
68
100
Muscodor albus
Xylaria hypoxylon
68
Xylaria curta
Xylaria polymorpha
72
100
Xylaria carpophila
Poronia punctata
Xylaria sp.
87
Rosellinia necatrix
Pestalosphaeria hansenii
98
Discostroma tricellular
93
Amphispaeria sp.
10

Fig. 5. Maximum parsimony phenogram of 18S rDNA sequences of Xylariales. Bootstrap confidence measures greater than 50% from 100 replications are indicated at internodes. Taphrinales is an outgroup. Bar = 10 substitutions.

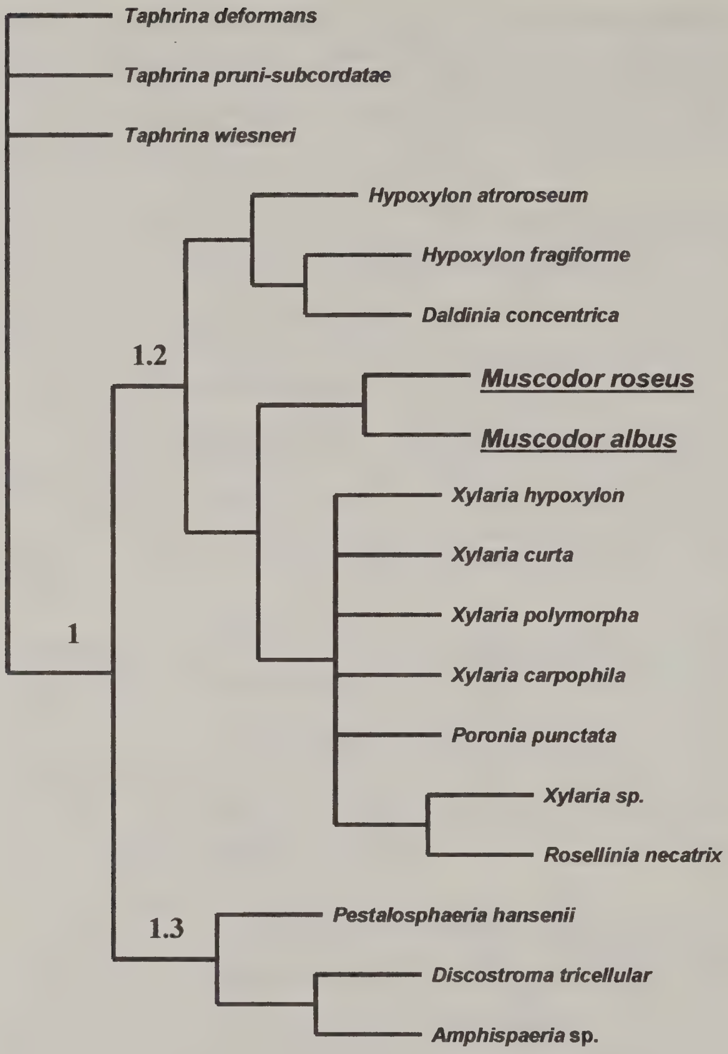

Taphrina deformans
Taphrina pruni-subcordatae
Taphrina wiesneri
Hypoxylon atroroseum
Hypoxylon fragiforme
Daldinia concentrica
1.2
Muscodor roseus
Muscodor albus
Xylaria hypoxylon
Xylaria curta
Xylaria polymorpha
1
Xylaria carpophila
Poronia punctata
Xylaria sp.
Rosellinia necatrix
Pestalosphaeria hansenii
1.3
Discostroma tricellular
Amphispaeria sp.

Fig. 6. A strict consensus phylogenic tree of 30 equally most parsimonious 18s rDNA cladograms shows *Muscodor roseus* and *M. roseus* should be placed in the family Xylariaceae, Xylariales. Internode 1, 1.2 and 1.3 represent selected taxa in Xylariales, Xylariaceae and Amphisphaeriaceae, respectively. Taphrinales is an outgroup.

CBS 148 (AF163033), *X. longipes* CBS 148.73 (AF163038), *X. mali* CBS 385.35 (AF163040), *X. cornu-damae* CBS 724.69 (AF163031), at 99, 91, 91, 91, 90 and 89% similarities, respectively. No total identities of either partial 18S rDNA or ITS1&2 and 5.8S rDNA sequences were found.

Phylogenetic analysis based on 18S sequences showed that *M. roseus* is a sister group to *Muscodor albus* (AF324337) with robust bootstrap confidence measured 100% from 100 replications (Fig. 5). In addition, maximum parsimony analysis shows that both *M. albus* and *M. roseus* are more closely related to the *Xylariaceae*, e.g. *Xylaria* spp., *Rosellinia necatrix* (AB014044) and *Poronia punctata* (AF064052) than to three representative genera of Amphishaeriaceae: *Pestalosphaeria hansenii* (AF242846), *Discostroma tricellular* (AF346546) and *Amphisphaeria sp.* (AF346545) with bootstrap confidence measured at 68% from 100 replications (Felsenstein, 1985) (Fig. 5). This result was also supported by a strict consensus heuristic search phylogenic tree of 30 equally most parsimonious 18S rDNA cladograms. Therefore, *M. roseus* should be placed in the family Xylariaceae, Xylariales (Fig. 6). Moreover, the results of the comparison of the 18S rDNA and the ITS1&2 and 5.8S rDNA of *M. roseus* "A3-5" possess high similarities to *M. albus* (Worapong et al., 2001). Also, the molecular biological data (18S rDNA) suggests that both isolates "A3-5" and "A-10" of *M. roseus* should be considered closely related, and virtually identical organisms. Furthermore, the molecular biological data provides some support of the concept for the division of *M. albus*, previously described, from this proposed new fungal species *M. roseus*.

Fungal Biology

While the molecular biology of *M. roseus* shows that this organism has the best fit into the group Xylariaceae, it also demonstrates close 18S rDNA relatedness to *M. albus.* However, because there is such relatedness at the limited rDNA molecular level, it may be argued that the two fungi are identical. Nevertheless, other chemical characters in both M. *albus* and *M. roseus* were examined and discovered to be different. Thus, while both *M. albus* and *M. roseus* shared the biochemical ability of producing a musty smelling odor, which has been demonstrated to have powerful antibiotic properties, many of the volatiles produced by these two organisms were identical as measured by GC/MS. It has been often noted that fungi do produce a variety of odorous substances, but the impressive antibiotic properties of *Muscodor* spp. seems to be unique (Bjurman and Kristensson, 1992; Rapoir et al., 2000; and Schnurer et al., 1999). However, the volatiles of these two fungi also contained different compounds (Strobel et al., 2001). As an example, *M. albus* produced 2-nonanone, caryophyllene, and acetic acid 2-phenylethyl ester, while these compounds were not detected in either isolate of *M. roseus.* On the other hand, both isolates of *M. roseus* made compounds not detected in *M. albus* volatiles, such as 2-butenoic acid, ethyl ester, 1,2,4, trimethyl benzene and 2,3 nonadiene (Strobel, Daisy, Sears, unpublished). This result lends some chemical support to the assignment given in this report suggesting that *M. albus* is taxonomically distinct from *M. roseus.*

Other, more classical features of *M. roseus* (isolates "A3-5" and "A-10") were also examined and compared to *M. albus.* These isolates of *M. roseus* produced a slow growing, dense, lightly rose colored mycelium on all media tested. This contrasts to *M. albus* that produces a whitish mycelium on all comparable media tested (Worapong et al., 2001). No spores formed on any medium including ones containing the host plant material or carnation leaves. Hyphae varied in diameter (0.8-3.6 μm) and were often intertwined to make more complex structures and even hyphal coils (Fig. 1-4). These hyphae were generally bigger than those of *M. albus*. The mycelia of *M. roseus* generally make more complex intertwined structures in culture than *M. albus* (Worapong et al., 2001). In fact, the appearance of hyphal coils of fungi in culture is not common, in our experience, and yet these structures often appeared in *M. roseus* cultures (Fig. 4).

Finally it is to be noted that for *M. roseus*, the best storage condition was after drying on filter paper and placement at -70°C. Under these conditions the fungus remains viable for over 1.5 years. Also, this fungus could be stored at 4°C in sterile water but with less certainty of recovering a viable organism after 6 months. Also, storage in 15% glycerol at -70°C effectively preserved the viability of the organism.

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MYCOACIELLA, A SYNONYM OF PHLEBIA

Karen K. Nakasone

Center for Forest Mycology Research
Forest Products Laboratory[1]
USDA Forest Service
Madison, Wisconsin

Abstract. *Mycoaciella* (Steccherinaceae, Stereales, Basidiomycota) is a genus of resupinate, hydnaceous, corticioid fungi with a dimitic hyphal system. Presently, three taxa are accepted in the genus: *M. bispora*, the generic type, *M. brunnea*, and *M. hinnulea*. As a result of this microscopic study, *Mycoaciella* is placed in synonymy with *Phlebia* (Meruliaceae, Stereales), two new combinations, *Phlebia bispora* and *P. hinnulea,* are proposed, and *Mycoaciella brunnea* is retained in *Ceraceohydnum*. The new combination *Phlebia badia* is proposed for *Odontia badia*, a species with a dimitic hyphal system of simple septate generative and thick-walled skeletal hyphae. *Phlebia bispora* and *P. hinnulea* possess a trimitic hyphal system consisting of thin-walled, nodose septate generative, thick-walled, aseptate skeletal, and slender, highly branched micro-binding hyphae. Resinous-capped hymenial cystidia are present in *P. bispora, P. hinnulea,* and *P. badia*. These three taxa and *C. brunneum* are described and illustrated.

Keywords. *Ceraceohydnum brunneum*, *Resinicium bisporum*, *Odontia hinnulea*, *Odontia badia*, *Acia denticulata*, micro-binding hyphae.

INTRODUCTION

Mycoaciella J. Erikss. & Ryvarden was described by Eriksson et al. (1978) based on the type species *Resinicium bisporum* Stalpers from Europe. They noted the similarity of *R. bisporum* to species of *Mycoacia* Donk except for the presence of skeletal hyphae. *Mycoaciella* is characterized by resupinate, ceraceous basidiomes with a hydnoid hymenophore, dimitic hyphal system of nodose septate generative and thick-walled skeletal hyphae, cylindrical cystidia with an apical cap of resinous-like material, clavate basidia with four sterigmata, and ellipsoid, thin-walled basidiospores.

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Mycoaciella remains a small genus that includes two other taxa: *M. hinnulea* (Bres.) Hjortstam & Ryvarden from Brazil (Hjortstam and Ryvarden, 1980) and *M. brunnea* (Jülich) Hjortstam & Spooner from New Guinea (Hjortstam et al., 1990). An investigation of the genus was undertaken to assess its relationship to *Mycoacia*, now a synonym of *Phlebia* Fr. (Nakasone, 1997). Type specimens of all *Mycoaciella* species and *Odontia badia* Pat. were examined. Descriptions and illustrations of the taxa are provided.

MATERIAL AND METHODS

Thin, freehand sections of specimens were mounted in a drop of aqueous potassium hydroxide (2% w/v, KOH) and aqueous phloxine (1% w/v) or Melzer's reagent (Hawksworth et al., 1995, p. 437) and examined with an Olympus BH2 compound microscope. Drawings were made with a camera lucida attachment. An Olympus zoom stereo microscope, model SZH, with a DP10 digital camera system, was used for photographs of the hymenophore. Color names are from Kornerup and Wanscher (1978) and Ridgway (1912), and herbarium abbreviations follow Holmgren et al. (1990).

DESCRIPTION OF TAXA

Phlebia badia **(Pat.) Nakasone, *comb. nov.*** Figs. 1, 2, 6
≡ *Odontia badia* Pat., Journal de Bot. (Morot) 11: 342. 1897.

Basidiome effused to marginally effused-reflexed, patches of fertile areas coalescing, up to 10 x 5 cm, thin, 70–350 µm thick between spines, crustaceous to subceraceous, hydnaceous with smooth, finely tomentose, loosely felty, or porose areas between spines, occasionally spines borne on tubercules, greyish yellow (3B6, 4B4) when fresh, then drying to greyish orange [5B(4–5)], yellowish brown [5D(6–8)] to brown [6(D–F)(5–8)] or Chamois, Honey Yellow, Cinnamon Buff, Buckthorn Brown, Tawny Olive, Sudan Brown, Cinnamon Brown or Saccardo's Umber; not reacting to KOH; cracks absent or extensive; context consisting of a thin, subceraceous, yellowish brown upper layer and a thicker, membranous, yellow to white lower layer next to substrate; hymenial surface of well-developed spines, spines long, slender, up to 2.5 x 0.1–0.4 mm, 2–4(–5) spines per mm, single or fused at base or along entire length, sometimes branched or bifurcate, terete to spathulate, smooth, ceraceous, brittle, tapering to an acute apex, dark brown to nearly black at base, then gradually turning brownish yellow toward apex, finally yellow to white at apex, occasionally developing a white, calcareus swelling along length of spine; margin up to 1 mm wide, indistinct, fibrillose or abrupt, adherent, finely tomentose, brownish orange (5C4) to greyish orange (5B4) when dried, light yellow (3A4) or greyish yellow (3B5) when fresh, edges with short, radiating, light yellow (4A4) to white strands or fascicles of hyphae.

Hyphal system dimitic with simple septate generative and thick-walled skeletal hyphae. Spines composed of a dense, central column of agglutinated skeletal and tramal hyphae, often moderately to heavily encrusted with coarse, hyaline crystals and with embedded brownish yellow, resinous-like materials, then enclosed by subhymenial and hymenial layers, apex sterile, consisting of protruding, typically dextrinoid, coarsely encrusted skeletal hyphae; tramal hyphae 1.5–4.5 µm diam, inflating up to 6 µm diam, simple septate, occasionally branched, agglutinated, walls thin to slightly thick, hyaline, occasionally dextrinoid, smooth or encrusted with loosely adherent coarse, hyaline crystals; skeletal hyphae 2–3.5 µm diam, unbranched, agglutinated, walls up to 2 µm thick but thinning toward base and apex, hyaline or dextrinoid, especially in spine apices, smooth or encrusted with loosely adherent coarse, hyaline crystals. Subiculum up to 350 µm thick, at first a moderately dense, homogeneous tissue of nonagglutinated hyphae, later developing a lower layer of dense, agglutinated hyphae arranged parallel next to substrate, 80–180 µm thick, and an upper layer of open, loose tissue of vertical hyphae, 150–250 µm thick; subicular hyphae 1–4 µm diam, simple septate, frequently branched, forming numerous H-connections, becoming agglutinated, walls thin to slightly thickened, hyaline, smooth. Subhymenium up to 100 µm thick, a moderately dense tissue of vertically arranged, short-celled hyphae; subhymenial hyphae 2–3.5 µm diam, simple septate, moderately to frequently branched, walls thin, hyaline, smooth. Hymenium consisting of a dense palisade of hyphidia, cystidia and basidia. Hyphidia rare to locally numerous, cylindrical to obclavate, tapering slightly to a rounded apex, 16–32 x 2–4 µm, tapering to 2–2.5 µm diam at base, simple septate at base, occasionally knobby or branched at apex, walls thin, hyaline, smooth. Cystidia abundant, clavate, 17–33 x 4–6 µm, tapering to 1–2 µm diam at base, simple septate at base, apex capped with a globular, yellowish-brown, homogeneous, transparent, resinous-like material, up to 15 µm diam, walls thin, hyaline, smooth. Basidia narrowly clavate to cylindrical, 17–25 x 4–5 µm, tapering to 1.5–2.5 µm diam at base, simple septate at base, 4-sterigmate, walls thin, hyaline, smooth. Basidiospores ellipsoid, (3.5–)4.5–5(–6) x 2–2.5(–3) µm, walls thin, hyaline, smooth, negative in Melzer's reagent.

Habitat. On wood and bark of angiospermous logs and branches.
Distribution. Costa Rica, Iran, United States (Florida), Vietnam.
Specimens examined. COSTA RICA. San José province, Hondura, 5600 ft, on (decorticated) hardwood, 20 June 1963, J. L. Lowe 12836 (CFMR). IRAN. Gilan, Asalem, on fallen (corticate) branch, 16 July 1976, L. and N. Hallenberg and D. Ershad, NH 1896, GB 23608, *ut Mycoaciella bispora* (GB); Gorgan, Khanbebin, Jangle shir abad, on (bark and moss of) fallen trunk, 7 July 1976, L. and N. Hallenberg and D. Ershad, NH 1633, GB 23606 and NH 1625b, GB 23607, *ut M. bispora* (GB); Mazanderan, Jangale liresar, S of Khorramobad, on fallen (decorticated) branch, 13 July 1976, L. and N. Hallenberg and D. Ershad, NH 1801, GB 23605, *ut M. bispora* (GB). UNITED STATES. Florida. Alachua County, Buzzards Roost, on *Quercus* sp., 21 July 1970, H. H. Burdsall, Jr., 4470 (CFMR). Gainesville, Sugarfoot Hammock, on *Quercus nigra* L., 27 July 1970, H. H. Burdsall, Jr., 4763 (CFMR). Leon County, Tall Timbers Research Station, Cypress Pond, on (bark and wood of) *Acer* sp., 24 July 1977, H. H. Burdsall, Jr., 9491 (CFMR). VIETNAM. (HN, Tonkin), Thinh Châu, vieux troncs de *Psidium*, 13 Oct 1891, Bon 4969 (FH, holotype of *Odontia badia*).

Remarks. The diagnostic characters of *P. badia* are the ceraceous, dark brown spines, simple septate generative hyphae, thick-walled, distally dextrinoid skeletal hyphae, capped cystidia, and small, ellipsoid basidiospores. Skeletal hyphae are found only in the spines, and the striking, but inconsistent, dextrinoid reaction of the walls at the apex can be observed in well-squashed sections mounted in Melzer's reagent. The reflexed feature is minimally developed but distinct in some specimens. The resinous-capped cystidia of *P. badia* are similar to those found in *P. bispora* and *P. hinnulea*.

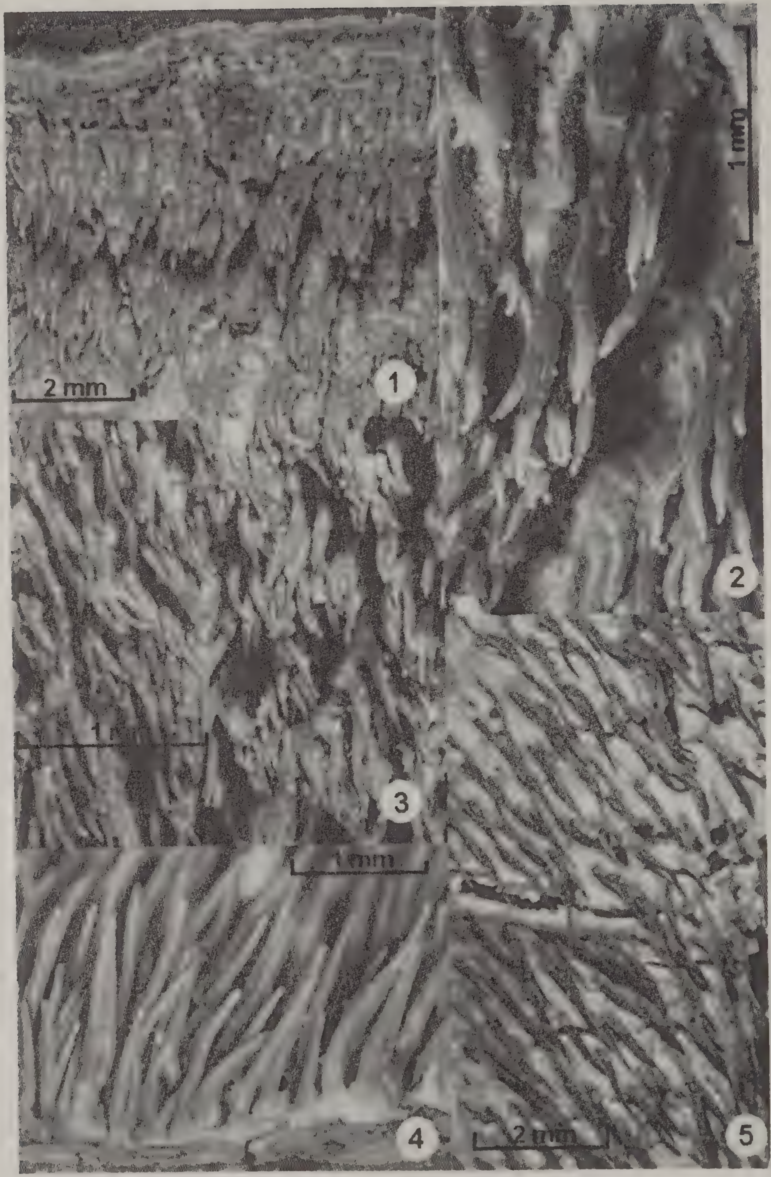

Fig. 1. *Phlebia badia* (HHB 4763). Overall appearance of basidome. Fig. 2. *Phlebia badia* (HHB 9491). Close-up of spines. Fig. 3. *Phlebia bispora* (holotype, H. Bourdot 4277). Overall appearance of basidiome. Fig. 4. *Phlebia bispora* (HHB 11756). Close-up of spines. Fig. 5. *Phlebia hinnulea* (holotype, 15 bis). Overall appearance of basidiome.

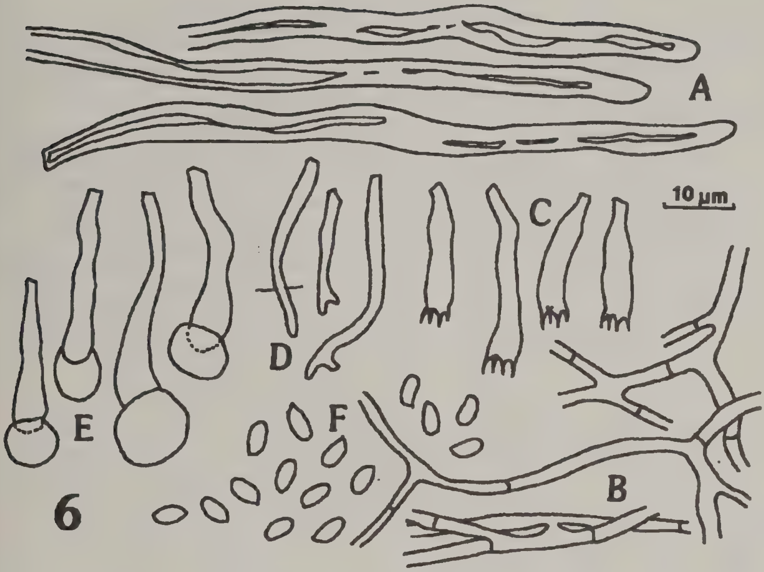

Fig. 6. *Phlebia badia*. Camera lucida drawings of microscopic elements. A, skeletal hyphae from spine trama; B, subicular hyphae; C, basidia; D, hyphidia; E, Cystidia; F, basidiospores. A, from holotype, Bon 4969; B–F, from HHB 9491.

At first, *Odonticium* Parmasto, characterized by small spines and simple septate hyphae, appeared to be a logical genus to place *P. badia*. However, *O. romellii* (S. Lundell) Parmasto, the type species, differs significantly from *P. badia* in its rather short, cylindrical basidia, allantoid basidiospores, thick-walled, constricted generative hyphae, and tough texture. The ceraceous spines, thickening subhymenium, narrowly cylindrical basidia, and ellipsoid basidiospores of *P. badia*, however, indicate that it is related to *Phlebia*. *Phlebia floridense* Nakasone, also with spines and simple septate generative hyphae (Nakasone and Burdsall, 1995), can be differentiated from *P. badia* by its monomitic hyphal system, pyriform cystidia, and very small spines.

The holotype specimen of *Odontia badia* is in poor condition as it is overgrown by several contaminating hyphomycetes. Well-developed spines are present only on the edges of several pieces of the specimen; however, mature basidia and a well-developed subiculum were not observed.

Phlebia bispora **(Stalpers) Nakasone, *comb. nov.*** Figs. 3, 4, 7

≡ *Resinicium bisporum* Stalpers, Persoonia 9(1): 145. 1976.

≡ *Mycoaciella bispora* (Stalpers) J. Erikss. & Ryvarden, Cortic. North Europe 5: 902. 1978.

Basidiome widely effused, >10 x 4 cm, thin, up to 180 µm thick, hydnaceous with distinct smooth, finely tomentose, or porose areas between spines, membranous, greyish orange (5B4), brownish orange (5C6), light brown [5D(5–7)] to brown (6D7); cracking

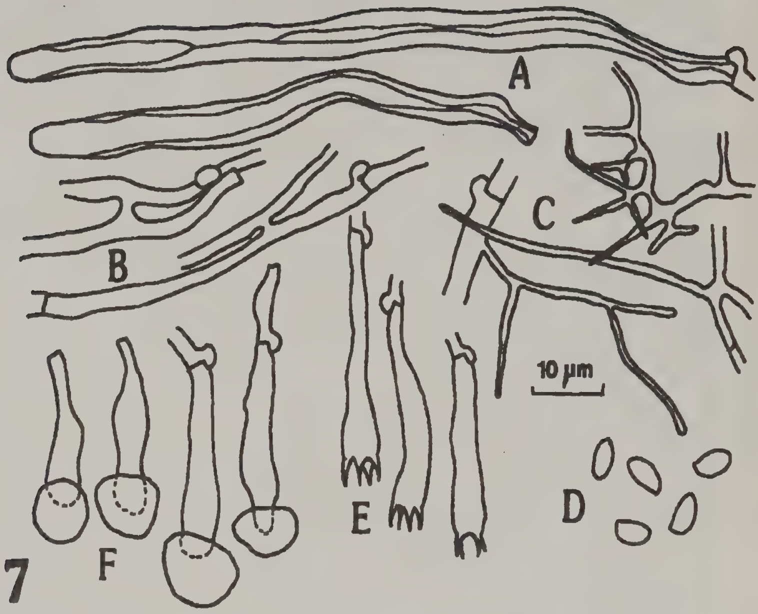

Fig. 7. *Phlebia bispora*. Camera lucida drawings of microscopic elements. A, skeletal hyphae; B, generative hyphae from spine trama; C, micro-binding hyphae; D, basidiospores; E, basidia; F, cystidia. A–D and F, from HHB 11756; E, from GB 758.

rare or absent; not reacting to KOH; context white, membranous; hymenial surface composed of long, slender spines up to 3 x 0.35 mm, 3–6 spines per mm, terete, subceraceous, brittle, single or fused at base, gradually tapering to an acute point or with a broad, setulose apex, apices sterile, white or concolorous with spines; margin up to 1.5 mm wide, abrupt, smooth, tomentose to felty with appressed to slightly raised, fimbriate edge or with small spines, then thinning out, with a white, fibrillose edge.

Hyphal system trimitic with generative, skeletal, and micro-binding hyphae. Spines composed of a core of skeletal and generative tramal hyphae arranged in parallel, sometimes with skeletal hyphae protruding through the sterile apex, then enclosed by thin subhymenial and hymenial layers; tramal hyphae 2–3 µm diam, nodose septate, moderately branched, often developing H-connections, walls thin, hyaline, smooth; skeletal hyphae arising from subiculum or within spine trama, 2.5–6 µm diam, clamped at base, unbranched, with secondary septa, walls up to 2.5 µm diam but thinning toward apex and base, hyaline, smooth or lightly encrusted with small, closely adherent, hyaline crystals. Subiculum 30–130 µm thick, a moderately dense to dense tissue of nonagglutinated, intertwined generative and micro-binding hyphae, in upper subiculum hyphae becoming vertical; subicular hyphae 1.5–4(–6) µm diam, nodose septate, moderately branched, not agglutinated, often irregular, walls thin, hyaline, smooth; micro-binding hyphae lacking to abundant in subiculum and substrate, 0.5–1 µm diam, aseptate, moderately to frequently branched, nonstaining in phloxine, walls hyaline, smooth. Subhymenium up to 30 µm thick, a compact tissue of short-celled hyphae; subhymenial hyphae 3–6.5 µm diam, inflating up to 8 µm diam, moderately to frequently branched, often irregular, walls thin, hyaline, smooth. Hymenium composed of a dense palisade of hyphidia, cystidia, and basidia. Hyphidia rare, cylindrical, 30 x 2 µm, with basal clamp connection, simple to knobby at apex, walls thin, hyaline, smooth. Cystidia abundant, embedded in hymenium or protruding up to 20 µm, cylindrical to slightly clavate or fusiform, 18–40(–65) x 3.5–6 µm, tapering to 1.5–3(–4) µm diam at base, with a clamp connection at base, capped with a spherical, brownish yellow, resinous-like material that is dehiscent and sometimes dissolving in KOH, walls thin, hyaline, smooth. Basidia narrowly clavate to clavate, 24–32 x 4.5–6 µm, tapering to 1.5–3 µm diam at base, with basal clamp connection, 4-sterigmate, walls thin, hyaline, smooth. Basidiospores broadly cylindrical to ellipsoid, (4.5–)5–6.5 x (2–)2.5–3 µm, walls thin to slightly thickened, hyaline, smooth; negative in Melzer's regent.

Habitat. On bark and wood of angiosperms.
Distribution. Czech Republic (Cejp, 1930), Denmark, France, Germany (Grosse–Brauckmann, 1983; Heller, 1989), Italy (Losi, 1999), Slovakia (Pilát, 1926), Ukraine (Nikolajeva, 1961), United States (Illinois, Louisiana, New York).
Specimens examined. DENMARK. Själland, Korsör skov., on (bark of) *Fagus* sp., 21 Nov 1959, K. Hauerslev 758 (GB). Fyen, Gamborg, Lindgravgaard i mergelgrav, på rodden pilestamme, 1 Nov 1956, M. P. Christiansen (GB). FRANCE. Allier, bordure Garnafag, entre le Mazeau et la Roche (Chappes), sur br. d'aune toucheé, 9 Août 1905, H. Bourdot 4277, ut *Acia denticulata* (Pers.) Bourd. & Galzin (PC, holotype of *R. bisporum*). GERMANY. Hessische Oberrheinebene, Kühkopf, Königsinsel, 17 Oct 1983, K.-H. Larsson and K. Hjortstam, KHL 4706 (GB); NSG, Kisselwörth, on overside of trunk of *Salix alba* L., 3 Nov 1980, H. Grosse–Brauckmann 1437 (GB). UNITED STATES. Illinois, Johnson County, Lower Cache River, on (wood and bark of branch of) *Nyssa sylvatica* Marsh., 9 Sept 1983, H. H. Burdsall, Jr., 11756 (CFMR). Louisiana, Baton Rouge, on wood and bark, 25 Aug 1909, C. J. Humphrey, FP 5427 (CFMR); on decaying (decorticate) poplar, 29 Jan 1886, A. B. Langlois 239, US0259007 (BPI). New York, Jamesville, Clarke Reservation, on (decorticate) hardwood, 30 Aug 1959, J. L. Lowe and R. L. Gilbertson, JLL 10792 (CFMR).

Remarks. *Phlebia bispora* is an uncommon species characterized by slender spines, trimitic hyphal system, resinous-capped hymenial cystidia, and broadly cylindrical basidiospores. The presence of micro-binding hyphae is reported for the first time. These hyphae are similar to those found in *P. chrysocreas* (Berk. & M. A. Curtis) Burds. Micro-binding hyphae were observed in the subiculum and substrate of most specimens cited. The skeletal hyphae remain in the axis of the spines and never penetrate the hymenium.

Macroscopically, the slender spines of *P. bispora* are similar to those of *P. aurea* (Fr.) Nakasone, and the narrowly cylindrical basidia, cylindrical basidiospores, and embedded, resinous-like materials of *P. bispora* also suggest a close relationship to the genus *Phlebia.* In particular, *P. subfasicularis* (Wakef.) Nakasone and *P. brunneofusca* (Hjortstam & Ryvarden) Nakasone & Gilb. appear to be dimitic because of the thick-walled, heavily encrusted, terminal, sclerified hyphae (up to 65–150 µm long) in the spines (Nakasone and Gilbertson, 1998). Although Stalpers (1976) believed that the capitate cystidia of *P. bispora* resembled those of *Resinicium* species, Eriksson et al. (1978) noted that this resemblance is superficial.

According to Stalpers (1976) and Eriksson et al. (1978), *P. bispora* was first labeled by Bourdot and Galzin (1914) as *Acia denticulata* (Pers.) Bourd. & Galzin. Thereafter, Cejp (1930), Pilát (1926), Nikolajeva (1961, as *Sarcodontia denticulata* (Pers.) Nikol.), and Parmasto (1967, as *Mycoacia denticulata* (Pers.) Parmasto) followed Bourdot and Galzin's concept of *A. denticulata.* Maas Geesteranus (1974, p. 531) concluded that the type of *Hydnum denticulatum* Pers. is a specimen of *H. ochraceum* Pers. Later, Stalpers (1976) renamed the Bourdot and Galzin specimens *Resinicium bisporum.*

The holotype specimen of *R. bisporum* (H. Bourdot 4277) is in very good condition, with abundant basidiospores and capitate hymenial cystidia. Skeletal and micro-binding hyphae were observed, but not mature basidia.

Other descriptions and illustrations of *P. bispora* can be found in Cejp (1930) as *A. denticulata*, Nikolajeva (1961) as *S. denticulata*, Stalpers (1976), Eriksson and Ryvarden (1978), Grosse–Brauckmann (1983), Duhem (1989), and Losi (1999). The specimens of *M. bispora* reported from Iran by Hallenberg (1981) are simple septate and are cited above as *P. badia.*

Phlebia hinnulea* (Bres.) Nakasone, *comb. nov. Figs. 5, 8

≡ *Odontia hinnulea* Bres., Mycologia 18: 42. 1920.

≡ *Mycoaciella hinnulea* (Bres.) Hjortstam & Ryvarden, Mycotaxon 10(2): 281. 1980.

Basidiome effused, appressed but loosely attached, up to 5.5 x 1 cm and 250 µm thick, hydnaceous with smooth, fertile areas between spines, cracking between spines and exposing a thin, white context; hymenial surface of well-developed spines, spines terete, slender, smooth, single, up to 2.5 x 0.3 mm, 2–5 spines per mm, tapering gradually to an acute, entire, sterile apex, brown (6E8) to pale yellow (4A3), fertile areas between spines pale yellow to cream colored; margin closely appressed, up to 1 mm wide, silky, blending into substrate or felty, white to tan, with a few, small developing spines.

Hyphal system trimitic with generative, skeletal, and micro-binding hyphae. Spines composed of a central core of skeletal and generative tramal hyphae in parallel and protruding through the sterile apex, then surrounded and enclosed by subhymenial and hymenial layers, hyphae at apex smooth or encrusted with adherent, finely granular crystals; tramal generative hyphae 2.5–3.5 µm diam, nodose septate, sparingly branched, walls thin, hyaline, smooth; skeletal hyphae cylindrical, slightly enlarged at apex and tapering gradually to the base, up to 250 x 5–10 µm, with basal clamp connection, arising in the subiculum and within the spine trama, walls hyaline to dark yellow, up to 3 µm thick but thinning toward the base and apex, smooth or encrusted at the apex with adherent, finely granular or rod-shaped, hyaline crystals. Subiculum of fertile areas between spines up to 180 µm thick, with hyphae arranged parallel to substrate in a dense, nonagglutinated tissue; subicular hyphae 2.5–4.5 µm diam, nodose septate, moderately branched, forming numerous H-connections, walls hyaline, thin, smooth; micro-binding hyphae scarce or abundant in substrate, up to 1 µm diam, aseptate, frequently branched, walls thick, hyaline, smooth. Subhymenium 35–50 µm thick, a dense tissue of vertically arranged short-celled, nonagglutinated hyphae, sometimes with embedded, dark gold-colored, resinous-like substances; subhymenial hyphae 2.2–6 µm diam, nodose septate, frequently branched, walls hyaline, thin, smooth. Hymenium a dense palisade of basidia and cystidia, sometimes with dark gold-colored, resinous-like substances embedded among the elements. Cystidia of two types: (1) numerous, arising from hymenium, clavate, 21–45 x 5–6.5 µm, tapering to 2–4 µm diam at base, with basal clamp connection, apex capped with a dark gold-colored resinous-like substance that is easily dislodged, 8–16 µm diam, walls hyaline, thin, smooth except at apex; (2) rare, found only in the type specimen, arising in the upper subiculum and lower subhymenium, cylindrical to narrowly clavate, 50–70 x 6–7 µm, tapering to 2 µm diam at base, with basal clamp connection, walls hyaline, thin, smooth except for apex that is encrusted with fine, closely appressed granules. Basidia narrowly clavate to cylindrical, 25–35 x 5–6 µm, tapering to 1.5–3 µm diam at base, with basal clamp connection, 4-sterigmate, walls hyaline, thin, smooth. Basidiospores cylindrical to ellipsoid, 5.5–7(–8) x 3–4 µm, walls hyaline, thin, smooth, negative in Melzer's reagent.

Habitat. On bark of angiosperms.
Distribution. Brazil.
Specimens examined. BRAZIL. S. Leopoldo, ad ramos Mimosae (on bark of small twigs, 10 mm diam), leg. Rick (S, holotype of *Odontia hinnulea*); S. Leopoldo, ad lignum frondosum, Rick 15 bis •20 (S, BPI-US0265786).

Remarks. *Phlebia hinnulea* is characterized by a trimitic hyphal system, hymenial cystidia capped with dark, golden-colored materials, and relatively large basidiospores. Microbinding hyphae were observed only in the substrate. Mature basidia were difficult to find. *Phlebia hinnulea* is similar to *P. bispora* but is easily distinguished by its larger basidiospores. *Phlebia hinnulea* also shares with *P. albida* H. Post ex Fr. and *P. albomellea* (Bondartsev) Nakasone a similar texture of the subiculum and arrangement and branching of the subicular hyphae. In addition, these taxa have relatively large basidia and basidiospores compared to other *Phlebia* species.

The above description is based on the available specimens. Hjortstam and Ryvarden (1980, p. 281) also described and illustrated *P. hinnulea*.

***Ceraceohydnum brunneum* Jülich, Persoonia 10(1): 138. 1978.** Figs. 9, 10, 11
≡ *Mycoaciella brunnea* (Jülich) Hjortstam & Spooner, Kew Bull. 45(2): 309. 1990.

Basidiome effused, appressed but easily separable, up to 10 x 5 cm, thin, up to 500 µm thick, ceraceous to corneous, hydnaceous to merulioid with smooth areas between spines and ridges, brown [6(E-F)8]; not reacting to KOH; cracks scarce; context usually bilayered with a thicker, dark brown, ceraceous upper layer and next to substrate a narrower, white lower layer (sometimes absent); hymenophore starting as low connecting ridges, then forming spines, spines long, slender, up to 3–4(–7) x 0.4 mm diam, 2–3 spines per mm, terete, single or fused at base, ceraceous, tapering to a sterile, acute apex, flexuous when dried; margins up to 4 mm wide, smooth to odontoid, easily separable from substrate, ceraceous and brittle when dried, brown (6D7).

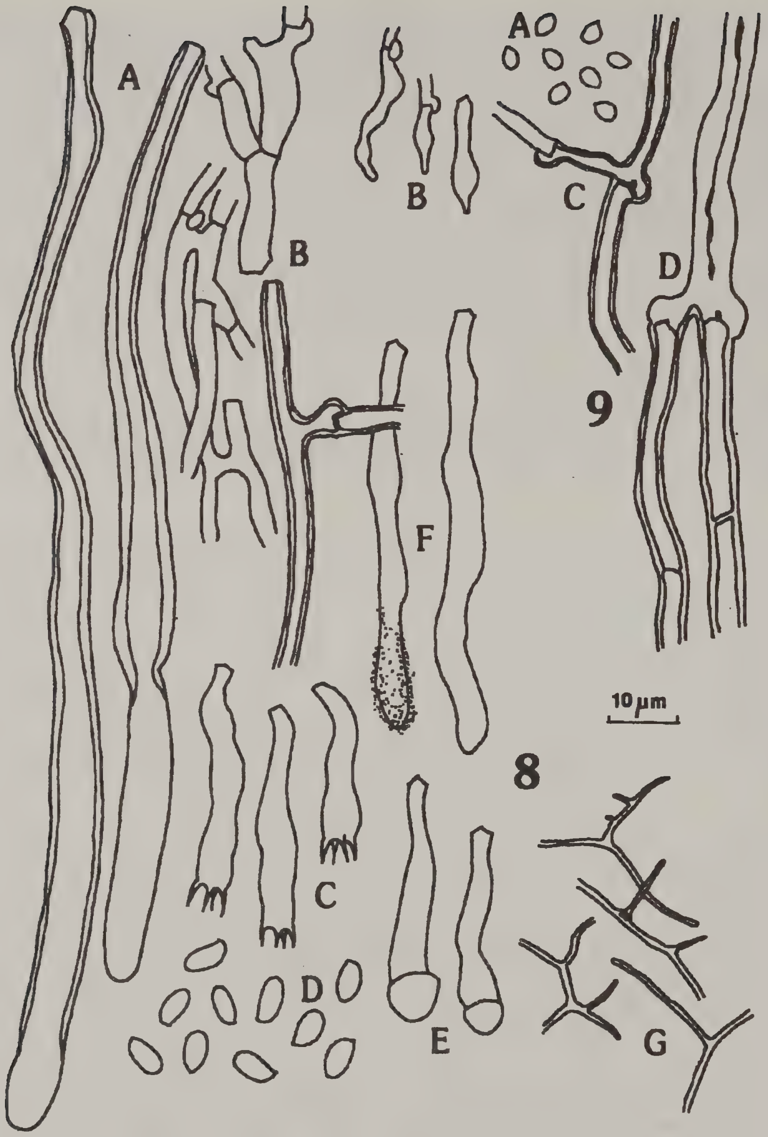

Fig. 8. *Phlebia hinnulea*. Camera lucida drawings of microscopic elements. A, skeletal hyphae; B, generative hyphae from spine trama; C, basidia; D, basidiospores; E, capped cystidia; F, cylindrical cystidia; G, micro-binding hyphae. A, from paratype, 15 bis 20; B–G, from holotype, 15 bis. Fig. 9. *Ceraceohydnum brunneum*. Camera lucida drawings of microscopic elements. A, basidiospores; B, cystidioles; C, tramal hyphae from spines; D, subicular hyphae. From holotype, C. E. Carr 13470.

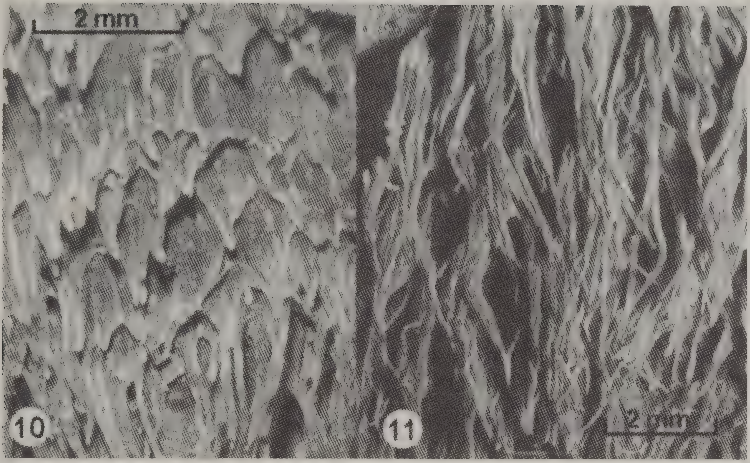

Fig. 10. *Ceraceohydnum brunneum* (holotype, C. E. Carr 13470). Merulioid appearance of basidiome. Fig. 11. *Ceraceohydnum brunneum* (holotype, C. E. Carr 13470). Close-up of spines.

Hyphal system dimitic with nodose septate generative and thick-walled skeletal hyphae. Spines composed of central column of closely appressed but not agglutinated skeletal and tramal generative hyphae enclosed by dense subhymenial and hymenial layers, with a sterile apex of thin-walled tramal hyphae; tramal hyphae 1.5–5.5(–6.5) µm diam, nodose septate, often with adventitious septa, sparingly to frequently branched, walls thin or up to 2 µm thick, hyaline, smooth; skeletal hyphae up to 270 x 2.5–4 µm, clamped at base, unbranched or with a short, lateral branch, walls up to 1.8 µm thick but thinning at apex and base, hyaline, smooth. Subiculum up to 400 µm thick, a dense tissue of thin- and thick-walled hyphae in parallel, upper subiculum becoming less dense and composed primarily of thin-walled, collapsed, indistinct hyphae; subicular hyphae (1.5–)3–5.5(–6.5) µm diam, nodose septate with secondary septa, sparingly to moderately branched, walls thin to 2 µm thick, hyaline, smooth. Subhymenium thickening, up to 54 µm thick, a dense tissue of vertically arranged, agglutinated, mostly indistinct or collapsed hyphae; subhymenial hyphae 1.8–2.2 µm diam, nodose septate, walls thin, hyaline, smooth. Hymenium generally degraded, consisting of cystidioles and basidia. Cystidioles scarce, cylindrical to fusiform, 10–20 x 2.5–4 µm, tapering to 2 µm diam at base, clamped at base, walls thin, hyaline, smooth. Mature basidia not observed. Basidiospores abundant, globose to subglobose, 3–3.5(–4) x 2–2.5(–2.8) µm, walls thin, hyaline, smooth, negative in Melzer's reagent.

Specimen examined: NEW GUINEA. Papua, Boridi, 700 ft. elev., over decaying log, 22 Nov 1935, C. E. Carr 13470 (holotype: L 0053258).

Remarks. *Ceraceohydnum brunneum* is characterized by a ceraceous, merulioid to spinose hymenophore, dimitic hyphal system, small basidia, and small, subglobose basidiospores. Although no basidia were observed in this study, Jülich (1978) described the basidia as narrowly clavate, hyaline, 4-sterigmate, 6–10 x 2.5–3 µm, with a basal clamp. Skeletal hyphae are limited to the spines, and although similar to the thick-walled subicular hyphae, they are morphologically distinct. Although *C. brunneum* was transferred into *Mycoaciella* (Hjortstam et al., 1990), it does not appear to be closely related to *M. bispora* or *Phlebia* because of its small basidia and basidiospores. The affinities of *C. brunneum* are not known at this time; therefore, it is accepted in the monotypic *Ceraceohydnum* Jülich.

DISCUSSION

Mycoaciella is placed in synonymy under *Phlebia*, necessitating the transfer of *M. bispora* and *M. hinnulea* into *Phlebia*. *Phlebia bispora* is reported from Europe and eastern United States, and *P. hinnulea* is limited to Brazil. Similarly, *Odontia badia,* with a circumglobal distribution, is transferred into *Phlebia*. *Mycoaciella brunnea*, however, is morphologically distinct from *Phlebia* and *Phlebia bispora* and is accepted under its original name, *Ceraceohydnum brunneum*.

A shared feature of *P. bispora, P. hinnulea*, and *P. badia* is the development of hymenial cystidia with a globular, resinous-like cap. Nevertheless, *P. bispora* and *P. hinnulea,* which share many morphological features and are probably closely related, do not appear to be closely related to *P. badia.* In particular, the overall membranous texture and open hyphal structure of the subiculum in *P. bispora* and *P. hinnulea* are more similar to that found in *P. albida* and *P. albomellea* than to the ceraceous texture and agglutinated subicular tissue of *P. badia*. Furthermore, the basidia and basidiospores are slightly smaller in *P. badia* compared with those in *P. bispora* and *P. hinnulea.*

Trimitic hyphal systems in corticioid fungi are unusual. The first trimitic corticioid species, *Schizopora trametoides* Suhirman & Núñez, was described by Suhirman and Núñez (1990). *Phlebia bispora* and *P. hinnulea* are the only other examples known at present. In these species, the trimitic hyphal system consists of generative, skeletal, and micro-binding hyphae. Skeletal hyphae occur only in the spine trama whereas micro-binding hyphae are found in the substrate and subiculum.

The term micro-binding hyphae refers to narrow (< 1 µm diam), highly branched, often at right angles, aseptate, nonstaining hyphae arising from generative hyphae (Nakasone, 2001). These hyphae are not commonly described in corticioid fungi and were referred to previously as "narrow, much-branched hyphae" in *Phlebia chrysocreas* (Berk. & Curtis) Burds. (Lombard et al., 1975), "branched skeletal hyphae" in *Amethicium* Hjortstam (Hjortstam, 1983), "quasi-binding hyphae" (Wu, 1990, p. 16), and "arboriform" in *Cericium* Hjortstam (Hjortstam, 1995). Micro-binding hyphae in corticioid fungi are more delicate and highly branched than are the binding hyphae present in the polypores (Gilbertson and Ryvarden, 1986, p. 21).

Skeletal hyphae occur more frequently than micro-binding hyphae in corticioid fungi. Skeletal hyphae are undifferentiated, unbranched or sparingly branched, and thick-walled, and they lack septa or clamp connections throughout their length, although occasional secondary septa may be present. Skeletal hyphae can be confused with sclerified generative hyphae or tramal cystidia. Typically embedded in the subicular trama, skeletal hyphae are labeled tramal cystidia if they terminate in or beyond the hymenium. The apices of tramal cystidia are often enlarged or encrusted. Sclerified generative hyphae differ from skeletal hyphae in that clamp connections or primary simple septa are present.

With the inclusion of *P. bispora, P. hinnulea*, and *P. badia, Phlebia* now contains species with increasingly diverse morphologies. In addition to the varied hymenophore types, the circumscription of *Phlebia* now includes monomitic, dimitic, or trimitic hyphal systems consisting of simple or nodose septate generative hyphae, with or without skeletal or micro-binding hyphae. Future phylogenetic studies may resolve the taxonomic significance of the morphological heterogeneity in *Phlebia*.

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INDEX OF FUNGI DESCRIBED FROM THE MUSACEAE

W. Photita[1], S. Lumyong[1], P. Lumyong[2], K.D. Hyde[3] and E.H.C. McKenzie[4]

[1] Department of Biology, Chiang Mai University, Chiang Mai, Thailand
[2] Department of Plant Pathology, Chiang Mai University, Chiang Mai, Thailand
[3] Centre for Research in Fungal Diversity, Department of Ecology and Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong
[4] Landcare Research, Private Bag 92170, Auckland, New Zealand

Abstract Fungi described from the Musaceae are listed alphabetically, under the major taxonomic groups of fungi. They comprise 204 species from *Musa* (1 zygomycete, 60 ascomycetes, 23 basidiomycetes, and 120 mitosporic fungi), and 5 species from *Ensete* (1 zygomycete, 2 basidiomycetes, and 2 mitosporic fungi). The original reference, collection and herbarium details, where known, are given for each species.

Keywords banana; *Ensete*; *Musa*; fungal type species

Introduction

The monocotyledonous family Musaceae contains two genera, *Musa* with 37 species and *Ensete* with 7 species (Price, 1995). The center of greatest diversity of wild *Musa* species, and the presumed center of origin of the group, is Indochina and South-East Asia, and it is here that the earliest domestication is considered to have occurred (Simmonds, 1962). We are investigating the mycota on the Musaceae, and towards this end present a list of fungi described from this family. When species that are now regarded as synonyms are included, *Musa* is the substrate for the type specimens of 60 ascomycetes, 23 basidiomycetes, 120 mitosporic fungi, and 1 zygomycetes. Only five species of fungi have been described on *Ensete*: *Cyphella musae*, *C. oudemansii* (basidiomycetes), *Macrophoma ensetes*, *Macrosporium ensetes* (mitosporic fungi), and *Mucor caespitulosus* (zygomycetes).

The first fungus to be described from the Musaceae was *Dothidea musae* (/*Phyllachora musae* (Klotzsch) Sacc.) (Klotzsch, 1833), an ascomycete on leaves of *Musa* sp., in India. Most ascomycete species on *Musa* spp. have been described from Taiwan (12) and Argentina (8).

The first basidiomycete to be described from the Musaceae was *Psathyra musicola* (Hennings, 1902) on leaves of *M. sapientum* from Tanzania. Most records of basidiomycetes on *Musa* are from Cuba (5).

The first mitosporic taxa to be described from the Musaceae were *Phoma musarum* and *Stachybotrys subsimplex* on *Musa* sp. from USA (Cooke, 1883). Most mitosporic fungi on *Musa* have been described from Taiwan (17), USA (8), Japan (7), and India (7).

Two zygomycetes have been described on the Musaceae, *Mucor caespitulosus* on wilting inflorescences of *Musa ensete* (= *Ensete ventricosum*) from Argentina, and *Mucor funebris* on fruit of Palmaceae and Musaceae from Argentina, Brazil, and Paraguay (Spegazzini, 1898).

The present list was prepared from an examination of *Sylloge Fungorum* (Saccardo 1882–1931, 1972) and the *Index of Fungi* (1940–). For each fungus, full bibliographic details are given; authors' names are abbreviated according to Kirk & Ansell (1992), journal titles are abbreviated according to Lawrence *et al.* (1968) and Bridson & Smith (1991), and books follow the abbreviations used by Stafleu & Cowan (1976–1988). Where information is available, the host plant is indicated and collection details for the type specimen are given, together with herbarium acronyms, which follow Holmgren *et al.* (1990).

Zygomycota

Mucor caespitulosus Speg., *Anales Mus. Nac. Hist. Buenos Aires* 6: 205 (1898).
Argentina, La Plata, on wilting inflorescence of *Musa ensete* (= *Ensete ventricosum*).
Mucor funebris Speg., *Anales Mus. Nac. Hist. Buenos Aires* 6: 204 (1898).
Brazil, Paraguay, Argentina, on fruit of Palmaceae and Musaceae.

Ascomycota

Amerodothis musae Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 53 (1959).
Taiwan, Nantou, Chungliao, on stem of *Musa cavendishii*, 3 July 1929, K. Sawada.
Antennularia tenuis Earle, *Bull. New York Bot. Gard.* 3: 302 (1905).
Puerto Rico, sooty mold on living leaves of *Inga vera* and of *Musa paradisiaca*, A.A Heller 6352.
Anthostomella molleriana G. Winter, *Hedwigia* 25: 101 (1886).
St. Thomé, on leaves of *Musa* sp., Moller.
Belonidium sclerogenum var. ***musicola*** Dennis, *Kew Bull.* 13: 461 (1959) [1958].
Bolivia, Prov. Nor-Yungas, Dpto. La Paz, Coroico, on *Musa sapientum*, 26 January 1956, R. Singer (B553).
Calonectria apoensis Petr., *Sydowia* 22: 392 (1968).
Philippines, Mindanao, Davao Province, Mt. Apo, on decayed leaf sheaths of *Musa texilis*, June 1924, M.S. Clemens 5268.
Capnodium musae Viégas, *Bragantia* 4: 32 (1944).
Brazil, Prov. St Paulo, Campinos, Faz. Sta. Elisa, on dead leaves of *Musa* sp., 4 June 1940, A.P. Viégas.
Ceratocystis musarum Riedl, *Sydowia* 15: 248 (1962) [1961].
Austria, Vindobona, on rotten wood of fruit peduncles of *Musa speciosa*, 21 February 1962, O. Riedl.
Chaetothyrium musarum Speg., *Anales Mus. Nac. Hist. Nat. Buenos Aires* 6: 297 (1899).
Argentina, Brazil, Paraguay, Uruguay, 1889–1893, on surface of fruit of *Musa paradisiaca.*

Chlorociboria musae Dennis, *Kew Bull.* 13: 460 (1959) [1958].
Bolivia, Prov. Nor-Yungas, Dpto. La Paz, Rio Yariza, on rotten fallen leaves of *Musa sapientum*, 23 February 1956, R. Singer (B1377).
Clavatisporella musicola K.D. Hyde, *Mycotaxon* 55: 276 (1995).
Indonesia, Irian Jaya, Jayapura, on dead leaf of *Musa* sp., May 1992, K.D. Hyde & N. Raga (BRIP 22403).
Coccomyces annulatus Sherwood, *Occas. Pap. Farlow Herb. Cryptog. Bot.* 15: 19 (1980).
Columbia, ca. 20 km from Aguazul, on fallen leaves of *Musa paradisiaca*, 14 June 1976, K.P. Dumont, S.E. Carpenter, M.A. Sherwood & L.A. Molina (NY).
Cryptosporella musarum J.N. Kapoor, *Trans. Brit. Mycol. Soc.* 51: 328 (1968).
India, Bhowali, on leaf sheath of *Musa sapientum,* 9 October 1959 (IMI 129507).
Diaporthe musae Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Math.-naturwiss. Kl., Abt. 1,* 116: 130 (1907).
Samoa, near Apia, on leaf of *Musa paradisiaca*, Rechinger.
Diaporthe musae Speg., *Anales Mus. Nac. Hist. Nat. Buenos Aires* 19: 363 (1909).
Argentina, on decaying petioles of *Musa sapientum.*
Dilophia punctata G. Winter, *Hedwigia* 21: 101 (1886).
St. Thomé, on rotten petiole of *Musa* sp., Moller.
Dothidea musae Klotzsch, *Linnaea* 8: 489 (1833).
India, on leaves of *Musaceae*, Wight.
Dothidella musae Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Math.-naturwiss. Kl., Abt. 1,* 116: 130 (1907).
Samoa, near Apia, on leaf of *Musa paradisiaca*, Rechinger.
Glomerella musarum Petch, *Ann. R. Bot. Gard. Peradeniya* 6: 223 (1917).
Sri Lanka, Panadere, on leaves of *Musa paradisiaca*, June 1916, no. 4805.
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ERRATA

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Page 7, line 18	for	*Miscoasous*	read	*Microascus*
Page 180, line 38	for	*Octaviana*	read	*Octaviania*
Page 265, line 21	for	*Kalaalia*	read	*Kalaallia*
Page 266, line 19	for	*Kalaalia*	read	*Kalaallia*
Page 278, line 15	for	*Kalaalia*	read	*Kalaallia*
Page 358, line 18	for	*Zygorrhinchus*	read	*Zygorrhynchus*
Page 467, line 27	for	*atroroseus*	read	*atroroseum*

Reviewers, Volume Eighty-One

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EDITORS OF MYCOTAXON

Pavel Lizoň
EDITOR-IN-CHIEF
Department of Cryptogams
Institute of Botany
Dúbravská 14, SK-842 23 Bratislava, Slovakia

David L. Hawksworth
BOOK REVIEW EDITOR
MycoNova, Calle Aguila 12
Colonia La Maliciosa, Mataelpino
ES-28411 Madrid
Spain

Karen D. Gettelman
INDEX EDITOR
7044 Amherst Avenue
St. Louis, MO 63130
U. S. A.

Grégoire L. Hennebert
FRENCH LANGUAGE EDITOR
32 Rue de l'Élevage
B-1340 Ottignies - LLN
Belgium

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